

# MACHINERY

March, 1911

## CARTRIDGE MAKING\*—1

### METHODS EMPLOYED BY THE DOMINION CARTRIDGE CO., LTD., IN THE MANUFACTURE OF RIM-FIRE CARTRIDGES

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FOR some time past the writer has intended to describe the processes employed in the manufacture of cartridges.

An opportunity recently presented itself to him while on a visit to Brownsburg, Province of Quebec, Canada, where the works of the Dominion Cartridge Co. are located. Through the courtesy of Mr. H. W. Brainard, president of the company, this intention materialized, and is here presented with the hope that it may interest the readers of MACHINERY because of the special character of the operations recorded.

The works of the Dominion Cartridge Co. are located in the Laurentian range of mountains, about two miles from the north shore line of the Canadian Pacific Railway. Of late years a branch line has been completed, connecting the Laurentian granite quarry with the main line, and a

Previous to the year 1900 the power was supplied to the plant by a water-wheel, a dam being built just above the works. This dam, which was at the foot of a slight fall in the river, gave a good pressure, but was not sufficient for the amount of power required. In order to obtain ample power, the company built a large stone dam about one-quarter of a mile from the works, and put in a barrel flume, shown in the upper view, Fig. 1. This flume supplies power to a turbine, which, in turn, drives an electric generator used in supplying current

to the various motors located throughout the works. This turbine also drives a generator which is used in supplying the plant with electric lights.

The Dominion Cartridge Co. was incorporated in the year 1887, the late Mr. Thomas Brainard being made president. At this



Fig. 1. General View of the Dominion Cartridge Co.'s Works, Brownsburg, Quebec—Flume which supplies Water to the Turbine

short line from this branch has been built for the exclusive use of the Dominion Cartridge Co.

A few words regarding the location of the buildings shown in Fig. 1, might here be of interest. The office, explosive works, packing department, loading departments and the building in which the shot shells are manufactured, may be seen in the background of the lower view, while the metallic works are shown in the immediate foreground. All the metallic cartridges are loaded in the explosive works, to which they are conveyed from the metallic works in trucks across a small bridge that spans the river.

\*For additional information on the manufacture of cartridges, and kindred subjects, see the following articles previously published in MACHINERY: "High Speeds—Touching on the Exterior Ballistics of the Modern High-powered Rifle," August, 1909, engineering edition; "The Drawing of Cartridge Cases for Quick-firing Guns," January, 1906, engineering edition; "Steps and Press Employed in Making Rapid-fire Cartridge Shells," December, 1905, engineering edition.

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time the company employed about fifty hands, the number of which has now been increased to over three hundred. Enough has been said, however, in regard to the history of this company, as the chief feature of interest to the mechanic is the methods of manufacture there employed.

This article, which is one of a series to be published in MACHINERY, will deal exclusively with the manufacture of rim-fire cartridges. As the 0.22 long-regular is a well known cartridge of the rim-fire type, it will be taken as an example, and the various methods employed in its manufacture will be described in detail.

#### Annealing and Washing the Cups

Up to the present time the Dominion Cartridge Co. has not thought it advisable to make its own cups, but buys them in cup form. Before any drawing operations can be performed on the cups, they must be annealed to make them ductile.

The cups are placed in a cylindrical cast-iron drum, shown in Fig. 2, which has holes, smaller in diameter than the smallest cups annealed in it, drilled around its periphery. These holes permit the heat to permeate, thus annealing the cups rapidly.

The cylindrical drum is provided with a slide or door, which is forced in when the cups are inserted. The drum is then rolled into the furnace, where it is rotated by means of a

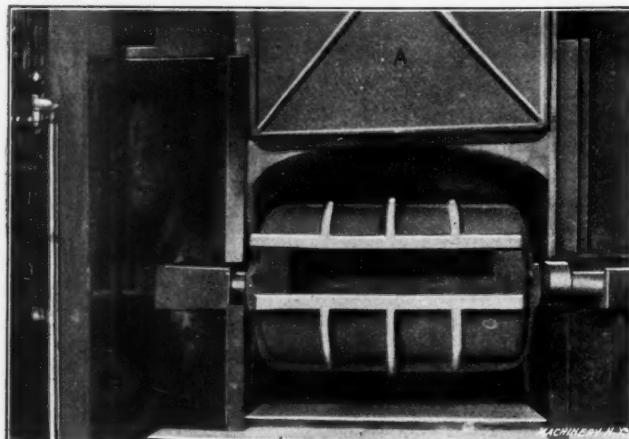


Fig. 2. Cylindrical Drum in which the Cups are annealed

chain and sprocket, driven by an overhead shaft. The door *A*, which is shown in the upper position in Fig. 2, is then brought down. Before the cups are inserted, the drum must be heated to a cherry red. Then the cups are put in and allowed to remain for a period of from thirty to forty minutes. After the cups have remained in the drum the specified time, the front door is raised and the drum rolled out. A truck with a pan located on it is then rolled in front of the annealer, the slide taken out, and the cups dumped into this pan, which is filled with lukewarm water.

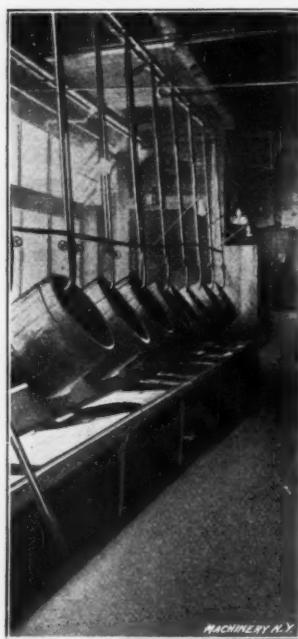


Fig. 3. Tubs used in Washing the Cups after Annealing

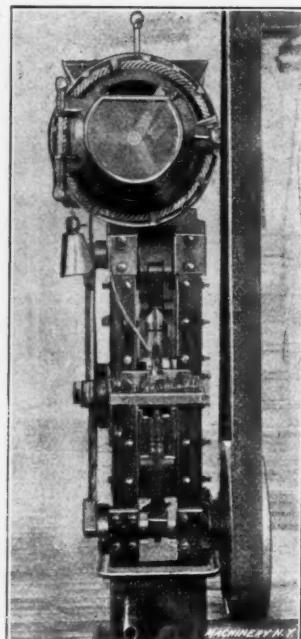


Fig. 4. Vertical Header with Automatic Feed

In the annealing process, a scale is formed on the cups, which would be detrimental in drawing; so before any drawing operations can be accomplished, they must be washed. To accomplish this, the cups are dumped into revolving tubs, as shown in Fig. 3. These tubs are driven by a shaft located beneath them, through bevel gears. A clutch is also provided, so that any one of the tubs may be stopped if desired, independently of the others. By rotating these tubs, the cups are made to rub against one another, thus helping to remove the scale. The rotating of the cups and the pouring of water on them is not sufficient to remove the scale, so they are immersed in a solution composed of sulphuric acid and water, mixed together in the following proportions: Water, 48 pints;

sulphuric acid,  $\frac{1}{4}$  pint. This solution is used for the first washing and removes the scale. When the cups look quite clean, a plug is removed and the acid solution washed off. Then the plug is inserted and another solution composed of pearlash soda, soft soap and water is mixed together in the following proportions: Water, 48 pints; soft soap, 1 pint; pearlash soda,  $\frac{1}{4}$  pint. The cups are rotated in this solution for about twenty minutes, after which they are rinsed with warm water. A sieve is located over the hole for the plug so that the cups cannot fall out. When the cups have been thoroughly rinsed and the water drained off, they are put in sieves, which, in turn, are placed in a cupboard, where they are held in racks. Steam pipes are located beneath these racks, so that the cups are quickly dried.

#### Drawing Operations

When dry, the cups are transferred to the drawing department. Here they are put in a pan, from which the operator removes them by means of a vulcanite plate. This plate has

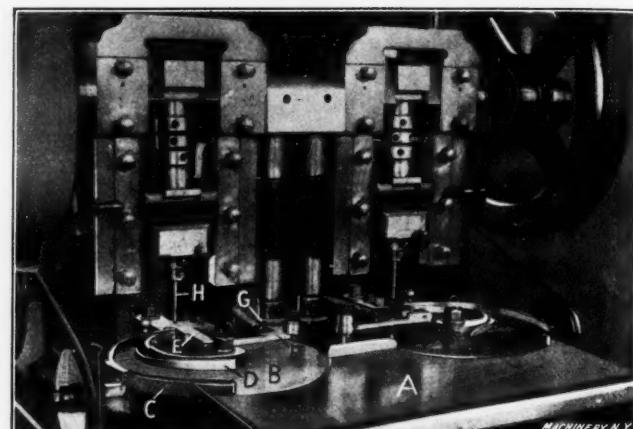


Fig. 5. Double-headed Friction Dial Drawing Press used for the Various Drawing Operations

a series of holes drilled through it, which are bell-mouthed on the top, and are slightly larger in diameter than the cups. A thin sheet-steel plate, bent up on two sides to fit the vulcanite plate, is slipped under it when shaking in the cups. When the cups are shaken into the plate, the operator places it on the table *A* of the double-headed friction-dial drawing press shown in Fig. 5, after which the sheet-steel plate is removed, and the vulcanite plate lifted up, leaving the cups standing on the table *A*. The operator then shoves the cups from the table onto the friction dial *B*, which carries them to the dies. These friction dials are driven through bevel gears by a round belt, which is connected through three grooved pulleys to the main driving pulley. The cups pass between the guard *C* and spring *D*, the latter being vibrated by the action of the revolving dial, which keeps the cups in constant motion, thus arranging them in single file. The guard *C* and the spring *D* approach each other as they near the dies to within a distance equal to the diameter of the cups. The cups are carried from the dial to the dies by a finger *E* con-

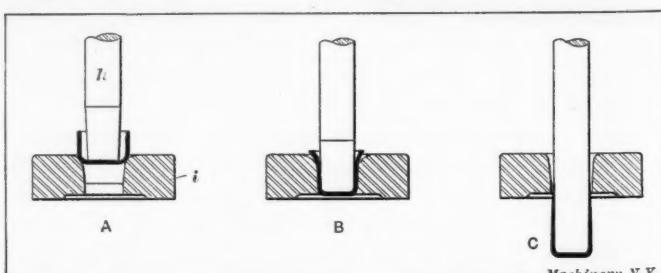


Fig. 6. Diagram showing the Action of Drawing the Cups

nected to the bell-crank *F*, which, in turn, is operated by the cam *G* on the end of a vertical shaft, driven from the crank-shaft through bevel gears.

The action of drawing the cups through the dies is clearly shown in Fig. 6. In operation, the cup is carried out by the finger and placed over the die *i*. The punch *h* then descends in it, as shown at *A*, forcing it down into the die, as shown at

B. In the latter position, the shell is given a mushroom shape, and is then forced through the die, as at C, reducing it in diameter, increasing its length and decreasing the thickness of its walls. As the cup is forced through the die, it expands slightly away from the punch, and on the upward stroke of the press it catches on the bottom of the die, and is stripped from the punch, dropping into a box placed under the machine. Only one die is shown in the illustration, but in actual practice two drawing dies are used, one on top of the other. The lower die is not bell-mouthed, but is slightly tapered.

In the drawing operations it is necessary to lubricate the cups, so that they will not stick to the die or punch, and for

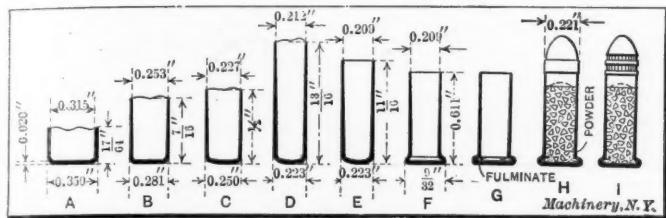


Fig. 7. Illustration showing the Transition from the Cup to the Finished Cartridge

this purpose a lubricant composed of soft soap and water is used. This is placed on the shells while they are located on the dial, by the operator, who spreads the lubricant over them, by means of a small cup fastened to a handle.

The punch for the drawing operations is made slightly tapered, being smaller at the lower end, as shown in Fig. 6. This is necessary, as the explosive material is placed near the head of the shell, thus requiring the walls of the shell to be thicker at this point than near the mouth.

After the first drawing operation, the cups are taken to the annealer, again annealed, washed and dried, in the

#### Trimming the Shell to Length

In the trimming operation the shells are dumped into the hopper A, shown at the top of the machine, Fig. 8, and pass from the latter into the revolving drum B, to which segments having pins C driven into them, are fastened. These pins, which are smaller in diameter than the inside of the shell, are pointed and set at an angle. As the segments carrying the pins rotate, the shells are agitated and drop onto the pins. The pins now carry the shells to the top of the hopper, and as they approach the perpendicular position, the shells drop off, and fall into the chute D, which is connected to the machine by a close-wound spring E, and tube F.

A better idea of the operation of this trimming machine can be obtained by referring to Fig. 16. Here the shells are shown dropping down the chute. They are held by a finger a, which presses against them, allowing only one shell to drop out at a time. In the position at A, one shell has dropped into the segment b, and the next shell is being held by the finger a. This finger is released by a cam, located at the rear of the machine. Attached to the face of the segment b is a sheet-steel plate c, the function of which is to prevent the shells from dropping out. This sheet-steel plate is held by a dowel pin and two screws as shown. Spiral springs are located under the heads of these screws, thus giving the plate the desired tension on the shell.

After the shells are located in the pocket, the segment is revolved in the direction of the arrow, carrying the shell into the horizontal position as shown at B. The punch d now advances and carries the shell out of the pocket into the chuck e. The chuck begins to close before the punch reaches the end of its travel, so that the punch can force the shell in to the correct depth. The punch d is held in a slide, actuated by an eccentric crankshaft which connects the punch-slide G

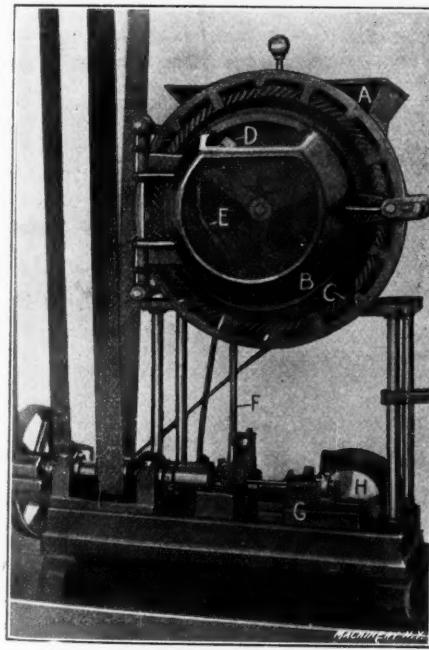


Fig. 8. Automatic Trimming Machine for Trimming the Shells to Length

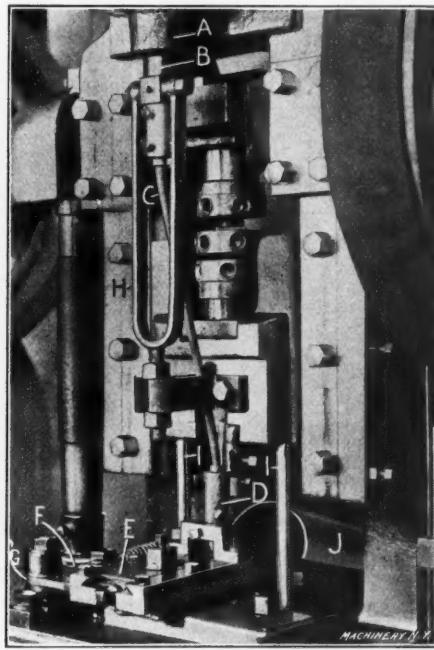


Fig. 9. Automatic Swaging Machine which forms the Slug into a Bullet

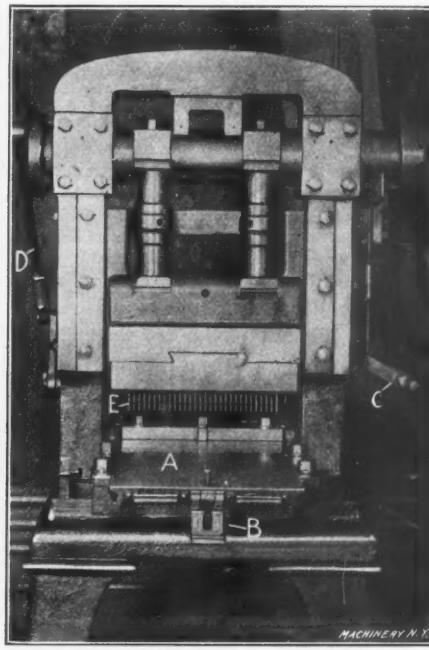


Fig. 10. Semi-automatic Loading Machine for Seating the Bullets in the Shells

manner previously described. They are then brought back to the drawing presses and given a second drawing operation. After this, they again pass through the operations of annealing, washing and drying, after which they are taken to the drawing presses where they are given the third or finish drawing operation.

The transition of the cup A to the shell is clearly shown in Fig. 7. Here the three drawing operations are shown at B, C and D, respectively. After the three drawing operations the shells are again washed and dried (not annealed), when they are taken to the trimmers, one of which is shown in Fig. 8. As is shown in Fig. 7, the mouth of the cup is not left perfectly straight after the drawing operations, but has ragged edges. Cracks also sometimes develop in the mouth of the shell, which make it necessary to trim off a certain amount, to obtain a perfect shell.

to the disk H (Fig. 8); the latter is driven from the rear shaft through bevel gears.

When the shell is located in the chuck the latter is closed by means of a cam located on the rear shaft of the machine, which operates through a lever forcing the beveled sleeve f forward. This beveled sleeve f raises the lever g to which the roll h is attached, and closes the chuck by means of the screw i pressing on the outer sleeve j. The punch d then retreats and the trimming tool k advances, trimming the shell to length. The inner face of this tool is slightly offset as shown, so that it will take a light shaving cut after cutting the end off. This makes a good finish and does not throw any burrs into the shell. The segment b now rotates back in the direction of the arrow as shown at B, into the position as shown at A, when the cycle of operations is continued. As one shell is trimmed it is forced by the following one through

the sleeve *l*, which passes through the spindle. The shells pass through this sleeve and drop into a box placed under the machine.

#### Forming the Head

Now that the shells are trimmed to length, they are ready for the heading operation. This is accomplished in a horizontal header of the semi-automatic feed type as shown in Fig. 14. Here the shells are dumped into the hopper *A*, from which they are taken by the operator, who, by means of a shaker, transfers them to the slide *B*. The shells are placed in this slide with the mouth facing the punch-head *C*. As the shells come down the slide *B* they rest in a pocket, from

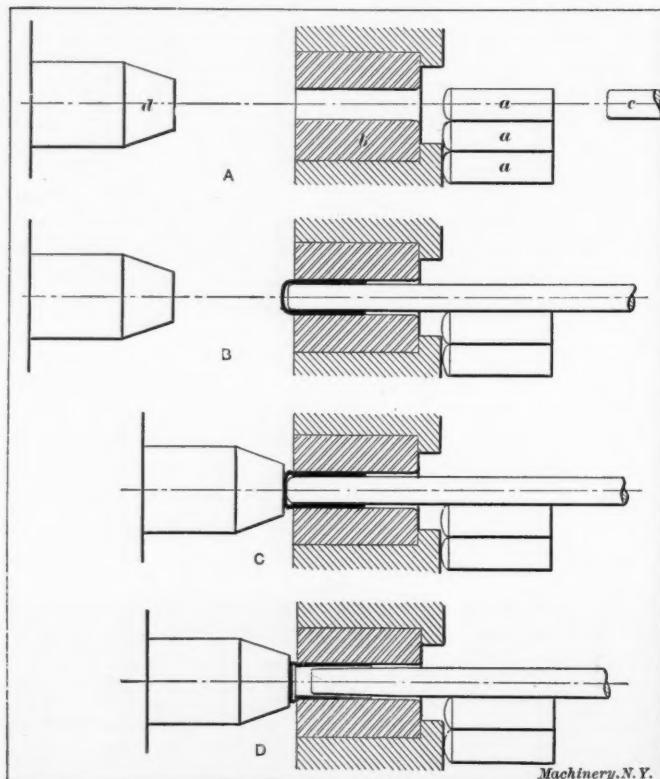


Fig. 11. Diagram showing the Action of Forming the Head on the Shell

which they are carried by the punch into the die, where they are headed by the bunter, held in the head *D*.

This heading operation is interesting, and is clearly illustrated in Fig. 11. At *A* are shown the shells *a* located in the pocket in front of the heading die *b*. The heading punch *c* and the bunter *d* are also shown back, out of operation. At *B*

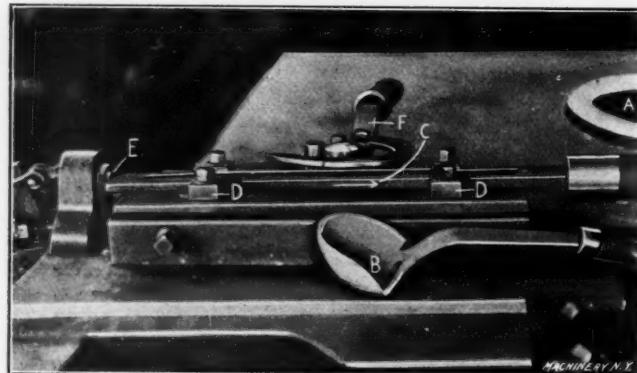


Fig. 12. Molds in which the Slugs for the Bullets are cast

the heading punch *c* has advanced and carried the shell into the die *b*. When in this position the heading bunter *d* advances, as shown at *C*, and commences to form the head on the shell. This action of the heading bunter upsets the head of the shell, close to the die, so that the heading punch can be withdrawn, as shown exaggerated at *D*, and the head on the shell completed. The punch and bunter now recede, and on the forward stroke of the punch it carries another shell into the die, forcing the previously headed one out, which is deposited in a box placed beneath the machine.

A heading machine equipped with an automatic feeding de-

vice is shown in Fig. 4. The feeding device is similar to that used on the automatic trimming machine shown in Fig. 8, so it will not be necessary to describe it further. The feeding of the shell to the die, however, is different to that shown in Fig. 14, the shell in this machine being fed by two fingers, one of which carries it from the tube connected with the hopper, to the other finger which transfers it to the die. This

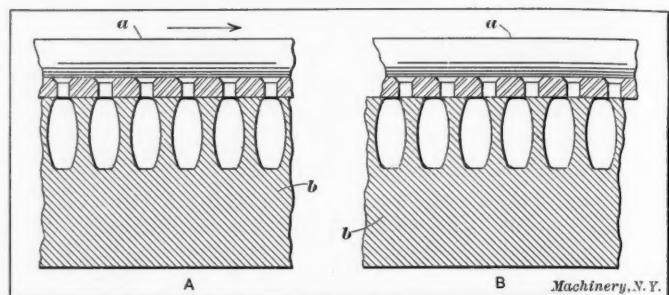


Fig. 13. Diagram showing how the Slugs are cast

header is seldom used for 0.22 long, its use being principally for heading B.B. and 0.22 short.

#### Priming—Putting the Fulminate into the Shells

After the shells are headed they are washed in the tubs shown in Fig. 3 and dried. They are then taken in a truck across the river and transferred to the priming department. Here the shells are shaken into plates and a charge of fulminate, which is held in a charger, is inserted in the shells. From the charging room the shells are taken to the priming machines, where they are placed on a friction dial which carries them to a punch. This punch has three grooves filed in its end, the function of which is to distribute the fulminate to the rim of the shell. As the punch is kept rotating, it forces the powder to the rim of the shell, by the action of centrifugal force, and locates it in a manner similar to that shown at *G* in Fig. 7. The fulminate is placed in the shells

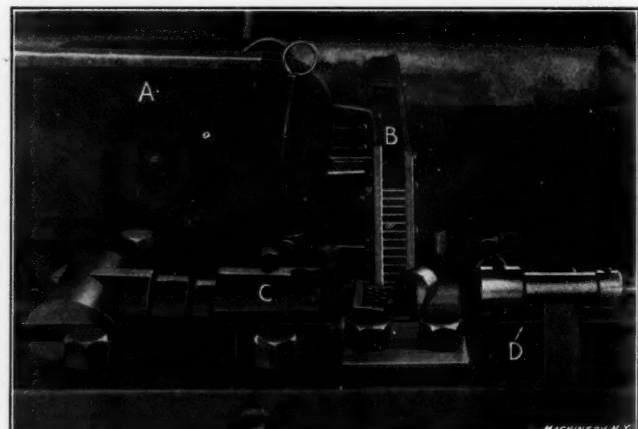


Fig. 14. Horizontal Header with Semi-automatic Feed for Forming the Head on the Shell

in a wet condition and will not discharge easily until dry. So the shells, after priming, are taken to what is called the "dry-house," where they are placed in sieves and left until dry in a very warm compartment, heated by steam. This completes the operations on the shell. We will next turn our attention to the making of the lead bullet.

#### Casting the Slugs from which the Bullets are made

Various devices have been tried for making the slugs from which the bullets are to be made. At one time a special machine was tried, which finished the bullet complete from a piece of lead wire. The wire was held on a spool and fed into the machine, where it was cut off and swaged. This machine did not prove satisfactory, however, owing to the fact that burrs were left on the ends of the slug as they came from the cutting-off dies, which prevented them from feeding properly into the swaging dies. The composition of the material used in making the bullets was also a governing factor in the discarding of this machine.

When this automatic swaging machine proved a failure, the

former method of making the bullets was reverted to. This consists in making the bullets first in slug form, and is accomplished by pouring molten metal into molds. These molds, which are made in halves, are shown in Fig. 12. The molten lead is kept at the correct temperature in the pot *A*, and is removed from it by the operator with the ladle *B*. The lead is poured into the filler *C*, which is located on top of the mold by guide blocks *D*. Then a foot lever situated beneath the machine is operated, forcing the pin *E* forward; this pin, in turn, moves the filler in the direction of the arrow, thus shearing the metal which has remained in the filler from that which has run into the mold. The operator now moves lever *F* to the left, which opens the molds and allows the slugs to drop

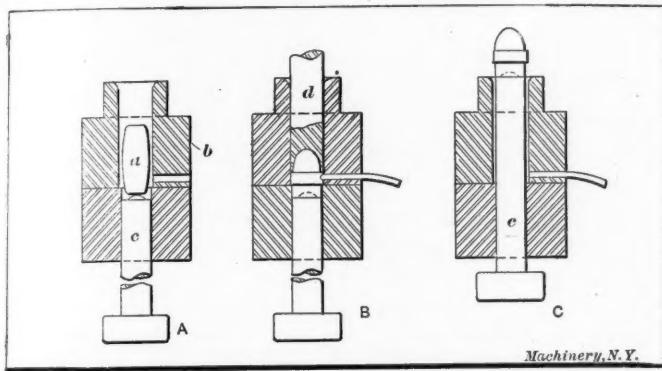


Fig. 15. Diagram showing the Action of Swaging the Bullets

out. The lever *F* is then moved to the right, closing the molds, and the operation is continued.

This operation is more clearly illustrated in Fig. 13, where a section of the filler and mold are shown. At *A* the filler *a* is shown in line with the holes in the mold *b*, when the metal is being poured in, and at *B* the filler is in the position that it occupies in relation to the mold after the metal has solidified and the foot lever is depressed. The surplus metal which is left in the filler is tapped out into the pot and remelted after the slugs which stick to the filler have been scraped off.

#### Tumbling and Inspecting the Slugs

The slugs as they come from the molds have fins and burrs on them, due to several reasons; one is that the operator does not close the mold tightly; another, that dirt or scrap gets in between the two halves of the mold, which leave fins on the slugs. If the slugs were taken to the swager in this condition, they would not pass down the tube, so it is necessary to tumble them to remove the fins and burrs. This is accomplished in an ordinary tumbling barrel which is revolved slowly. After the slugs are tumbled they are then dumped on a bench and inspected. This inspection consists in removing "half-slugs" and imperfectly formed ones. "Half-slugs" are due to the molder not having sufficient metal in his ladle to fill the mold. These would make imperfectly formed bullets, of light weight, which, of course, are undesirable.

#### Swaging the Bullets

After the slugs have been inspected and all half-slugs or imperfectly formed ones have been picked out, they are dumped into a hopper *A* (only the lower portion of which is shown), located at the top of the swaging machine shown in Fig. 9. From this hopper they drop down a tube *B* into the close-wound spring *C*. This close-wound spring *C* connects the tube *B* with the pocket or receptacle *D*, located over the finger-slide *E*. From the pocket the slugs are carried to the dies by fingers, which are held to the slide *E*. This slide is actuated by a bell-crank *G*, which is given a reciprocating motion by a cam *F*, fastened to a vertical shaft, and driven from the crankshaft through bevel gears. The slugs would not come down the sleeve and spring of their own accord, so it is necessary to agitate them. This is accomplished by fastening a yoke *H* to the ram of the press, and attaching this yoke to the sleeve *B*. The movement of the ram carries the sleeve *B* up and down in the hopper, which action agitates the slugs and causes them to drop down. The bullets are removed from the die by a knock-out connected to the ram of the machine by two studs *I*.

The action of swaging the bullets is more clearly shown in Fig. 15. The swaging dies are made in two pieces and are ground and lapped on the surfaces which come in contact. At *A* the slug *a* is shown as it drops down into the die *b*, and is located on the die-pin *c*. In the position shown at *B* the ram of the press has descended, carrying the punch *d* into the die, which action forms the bullet. The punch in forming the bullet, forces the excess material out of the vent hole provided in the upper die. This action is very interesting, as the excess material is gathered from the slug and forced out of the vent hole in the form of short wire. As the bullet is formed, the ram of the press again ascends and in its ascent the die-pin *c* is pushed up through the dies, carrying the base of the bullet flush with the top of the die. The bullet is removed from the top of the die by the fingers as they carry another slug to the die, and falls into the chute *J*, shown in Fig. 9. This swaging operation finishes the bullet to the exact size and also to the correct weight. The bullet for the 0.22 long-regular weighs thirty-five grains.

#### Loading—Putting the Powder and Bullets into the Shells

Now that the shell and bullet are completed, they are ready for loading. Both the bullets and shells are removed to an outside building where the loading machines are located. The shells are first shaken into what is called a "shell plate," which has a baseplate doweled to it. The bullets are shaken into a bullet plate, and the powder is then put in a charger which has holes in it registering with the holes in the shell plate,

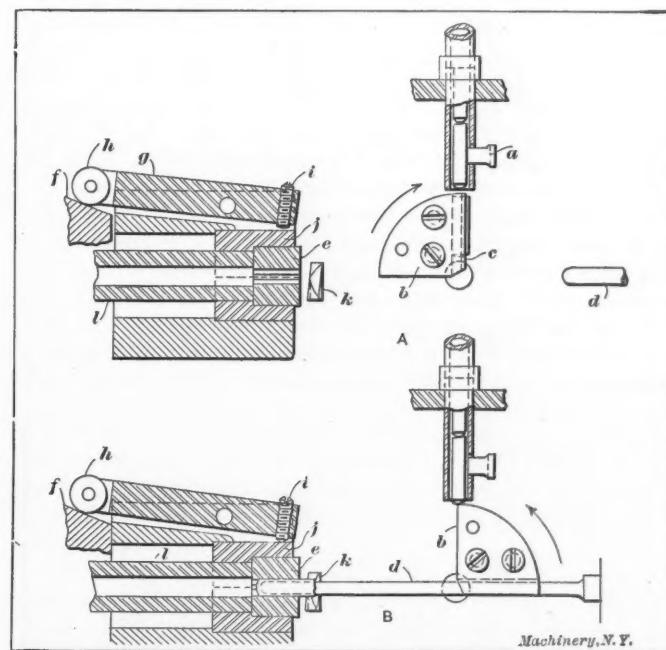


Fig. 16. Diagram showing the Action of the Automatic Trimming Machine

and slightly smaller in diameter than the inside of the shells. The thickness of these charging plates governs the amount of powder that is put in the shells. The charging plate is now located over the shell plate and tapped slightly, causing the powder to drop into the shells. The charger plate is then removed and the bullet plate substituted, being located by dowels. Both plates are taken to the semi-automatic loader, Fig. 10. (This loader is shown with the plates removed). The plates are put on the table *A*, and held by the clamp-bolt *B*. When everything is set properly, the operator presses the hand lever *C*, thus starting the machine. He then steps back from the machine, as occasionally a number of cartridges, and in some cases a whole plate of cartridges, explode, making it dangerous for him to stand in close proximity to the press.

The table *A* on which the loading plates are held is moved forward by means of a pawl engaging in a rack, fastened to the under side of the table. The table is moved a distance equal to the space between a row of holes for each stroke of the press. The pawl is actuated through a series of levers and the arm *D* which is connected eccentrically to the crank-shaft of the press. When the last row of shells in the plate

has been operated on by the row of punches *E*, the machine is automatically stopped by a trip lever at the back of the machine.

A clearer idea of the method of loading the cartridges may be obtained by referring to Fig. 17. Here at *A*, the shells and bullets are shown located in the shell and bullet plates *a* and *b*, respectively, ready for assembling, or seating; and at *B* the bullets and shells are shown assembled, by the action of the seating punches *c*. The plates are now removed from the press, and the slip plate *d* removed, when the loaded cartridges drop out. After the bullets have been seated in the shells, the loaded cartridges are taken to an automatic machine, where they are crimped and cannelured.

#### Crimping and Canneluring

Crimping the cartridges consists in tightening the shell around the bullet, as shown at *I* in Fig. 7, to prevent the latter from falling out, and also to increase its velocity. This operation is performed in the automatic machine shown in Fig. 18. The loaded cartridges are dumped into the hopper *A* through which passes a belt (inclosed in the box *B*) having scoops fastened to it. These scoops *C*, carry the cartridges out of the hopper up to the top of the slide *D*. Here the cartridges drop out of the scoops into the slide. The slot in this slide is slightly larger than the body of the shell, but is smaller than the head, so that it is impossible for the shells to go down the slide unless they are head upwards.

As the cartridges come down the slide *D*, they come in contact with the wheel *E*, which is rotated by a round belt *F*. This wheel has slots cut in it, in which the cartridges hang, the under sides of the heads bearing on the periphery of the wheel, and as the latter is kept rotating it deposits the shells on the revolving dial *G*. The guard *L* prevents the cartridges from dropping out before they reach the dial. As the cartridges drop out of the wheel *E* onto the dial *G*, they are guided by the block *H*. The dial *G* rotates in the direction of the arrow and carries the cartridges around where they are lined up by the guide *I*. As they continue in their travel, they pass between the stationary segment block *J* and the revolving dial *K*, the action of which rotates the cartridges and performs the crimping and canneluring operations. As they pass around still further they are removed from the dial by a guide and drop into a box. The canneluring is done by means

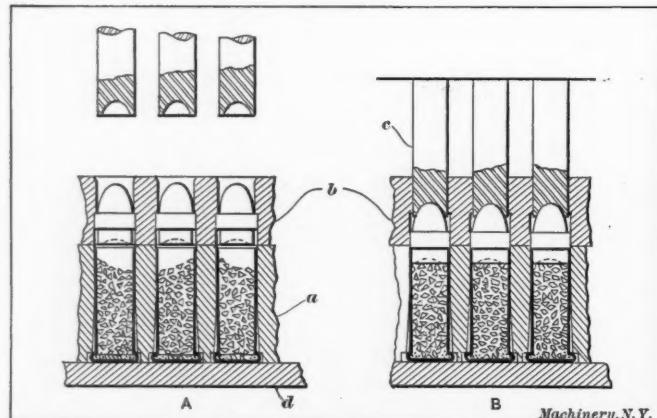


Fig. 17. Diagram showing how the Bullets and Shells are assembled

of narrow knurled projections formed on the edges of the dial *K*, which is fastened to the dial *G* and the segment block *J*. The crimping is also done by forms on the above-mentioned parts.

#### Greasing, Packing and Testing

The cartridges are now completed, as regards the manufacturing operations, and are ready for greasing and packing. Greasing is only done when the bullets are made from commercially pure lead, and not of composition of from 3 to 5 per cent tin. When made of the composition it is not necessary to grease the bullets. The object of the greasing is to prevent them from leading the bore of the rifle. The 3 to 5 per cent composition has the same effect as the grease, but is much cleaner and of a more finished appearance. The can-

neluring as shown at *I* in Fig. 7, forms narrow knurled grooves, during the crimping operation for the purpose of holding the grease.

If the bullets are made from commercially pure lead, they are shaken into plates and dipped into molten grease. The grease just sticks in the canneluring, leaving the remainder of the bullet practically clean—that is, if the grease is at the proper temperature. If slightly cooler than the correct temperature, the grease will form in clogs on the bullet, which have to be removed by wiping them with a rag. The shaker plates are now located on a packing plate. This packing plate has three hundred holes drilled through it in groups of fifty,

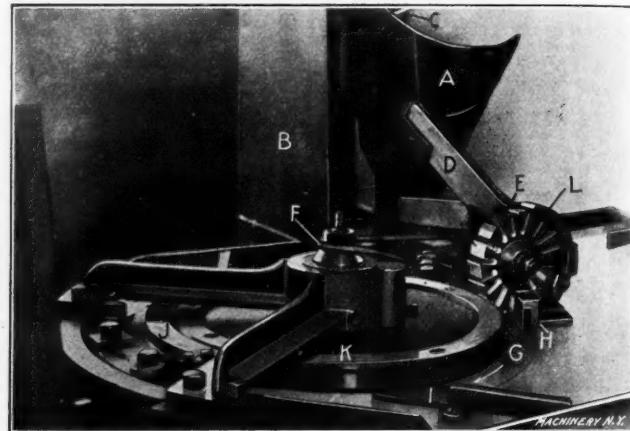


Fig. 18. Automatic Crimping and Canneluring Machine

which is the number of cartridges put in each box. The shaker plate holds only half the number of cartridges that the packing plate does, so it requires two shaker plates to fill the packing plate.

In operation, the first shaker plate is placed over the packing plate, and both plates are then turned over, when the shells drop into the packing plate. The shaker plate is then removed and a slip plate substituted for it. Another shaker plate is placed over the packing plate and the same operation repeated. This fills the packing plate and leaves half of the cartridges in the plate with their heads up, while the other half are reversed. The cartridges are now removed from the packing plate and placed in a slide provided with compartments, from which they are removed and placed in boxes. This packing arrangement is semi-automatic, and is considerably quicker than packing by hand.

Even though the cartridges have passed by all the inspections necessary for the manufacturing operations, they are still not ready to ship, but have to pass through a rigid test. A number, picked at random, are taken to the testing department where the tester in charge tests them for accuracy. As these cartridges are used only for sporting purposes, their velocity is not of very great importance, but they have to be correct as regards accuracy, which is of prime importance. There are various methods of testing the accuracy of the cartridge. One is to locate the rifle in a stock which holds it rigidly. The sight is then located accurately over the bull's eye, the trigger pulled, and the result noted. The cartridge is also tested for accuracy by off-hand shooting, and other similar tests.

\* \* \*

Pitching-tanks consisting of U-shaped tanks installed on shipboard and extending from port to starboard through the hold have been used successfully for preventing the rolling of ships on two medium-sized Hamburg-American liners. The invention is that of Herr Frahm, and the principle of the pitching-tank is that the water which rises and falls in the tank as the ship rolls neutralizes the movement of the latter. On the liners on which these pitching-tanks were installed, the rolling amounted to 11 degrees without the tanks; with the tanks in operation, this rolling was reduced to 2 degrees. It is stated in the *Mechanical Engineer* that the Hamburg-American line has directed that its new 60,000-ton steamer recently ordered is to be equipped with these pitching-tanks.

## THE MAKING OF A KNIFE-EDGE SQUARE

By T. MILLER\*

For very fine work on gages, instruments and some kinds of tools, a square with a flat-edge blade will not answer the purpose, for the simple reason that the contact between the work and the edge of the blade is too broad, so that the light will be shut out when they are not really together at all; and the paper-strip method will not answer, because the paper is too uneven in thickness and too rough to give the required accuracy, and besides, most work of that character would be too small to handle in that way; so what are called "knife-edge squares" are used. For some reason—probably because of their necessarily high cost—this class of square, as far as the writer knows, is only made by one tool manufacturer and the few that are in use have mostly been made by the workmen using them.

A hardened steel square of a size usually below the three-inch, such as shown in Fig. 1, is sometimes used as a starter. The blade is heated and then taken out of the stock, and the latter is then refinished on its two edges by grinding and lapping until they are flat and as nearly parallel to each other as it is possible to get them by the use of the micrometer caliper or other gaging device. The inside and sometimes the outside edge of the blade is next beveled, as shown in the enlarged sectional view. The sharp edge is also slightly rounded like a knife-edge straightedge. The blade is then put in place in the stock, care being taken to have the contact surface nicely tinned and all the surplus solder removed. The stock and blade are set by trying on a block, preferably hardened, which is as nearly square as it is possible to make it, and then temporarily held by a clamp on the sides of the stock and over the blade. The parts are then heated sufficiently to melt the solder and secure the blade. On account of the heating necessary and the disturbing influence of contraction and expansion, it will be found rather difficult to get the blade set even approximately right, and sometimes as many as four or five trials are necessary. After this, hand lapping is resorted to in order to bring it to the required degree of accuracy.

This difficulty in setting the blade has led to several designs in which the blade is held by pins, screws or keys, doing away entirely with the necessity for heating. A square of

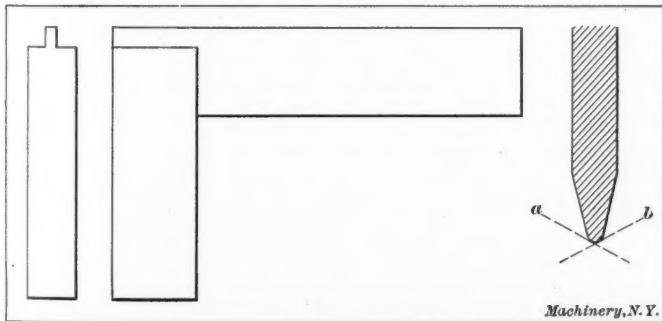


Fig. 1. Try Square and Enlarged Section of Knife-edge Blade

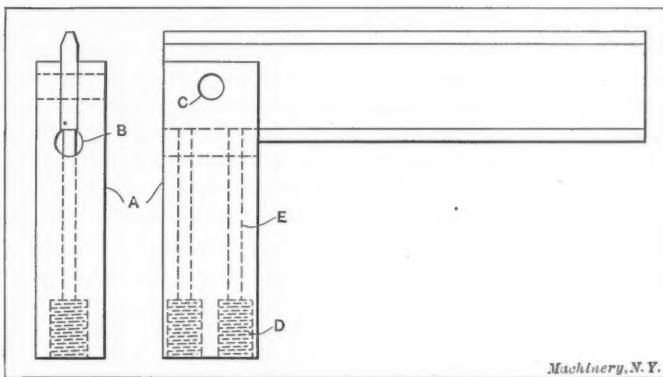
this variety, which has given entire satisfaction, is shown in Fig. 2. Every piece in this tool is hardened, even the screws and pins, as it is found that by so doing they "stay put" for a longer time. The stock *A*, is made of a single piece. The slot holding the blade ends in a round hole *B*, which serves the purpose of preventing fire cracks during hardening, and provides a clearance that is useful when lapping out the slot; the latter must fit the blade, which has previously been finished, closely—without play. The stock and blade are pivoted together and the blade is free to turn on pin *C* which need not be fitted with any great accuracy. In the stock are the two screws *D* and above them the two loose drill-rod pins *E*. It will be seen that with this construction, the blade may be quickly and accurately set and held firmly, and that when the fine edge of the blade becomes worn, it is a very small job to remove and reset it—that is if we have a square block to which to set it.

A good form of testing block for squares is shown in Fig. 3.

\* Address: Bridgeport, Conn.

This block should be of either tool steel hardened or machinery steel casehardened, and the sides, or edges, should be slightly longer than the square blade. This block is made in the following manner: From one side, the center is milled out, merely to make it lighter and more convenient to handle. After hardening it should be immediately drawn, slightly, to take out the strains—preferably in hot sand or oil and as slowly as possible. The block is then ground on a surface-grinding machine on its flat side and four edges, and all these are made as nearly square to each other as it is possible to get them by grinding. Then, unless the job is urgent, the block should be laid away at least a week, to allow it to settle before beginning to finish by lapping—the longer the seasoning period, the better.

It will, of course, be understood that for work of this character, the lap must be very true and flat to be of any use



Machinery, N.Y.

Fig. 2. Square with Adjustable Blade

whatever. A good lap for this purpose, and for general tool and gage work, should be about 15 by 24 inches, of cast iron, with the face cast downward. In form it is a flat plate, 2 inches thick, ribbed on the under side with ribs  $\frac{3}{4}$  inch thick and 4 inches deep, arranged like the ribs on the Brown & Sharpe surface plates, and bearing its weight on three points to avoid springing. To be able to get a flat plate and do anything like fine work, it is necessary to have three of these plates, all alike. They should be planed smooth on all four edges and on the top, which should also have grooves planed in it, running lengthwise only, about  $\frac{1}{4}$  to  $\frac{5}{16}$  inch apart, and of a shape that would be made by a 60-degree thread tool with the point slightly rounded. These grooves should be about  $\frac{3}{64}$  inch wide at the top and planed in at one cut, so that they may be slightly rough on the edges, to hold the emery better.

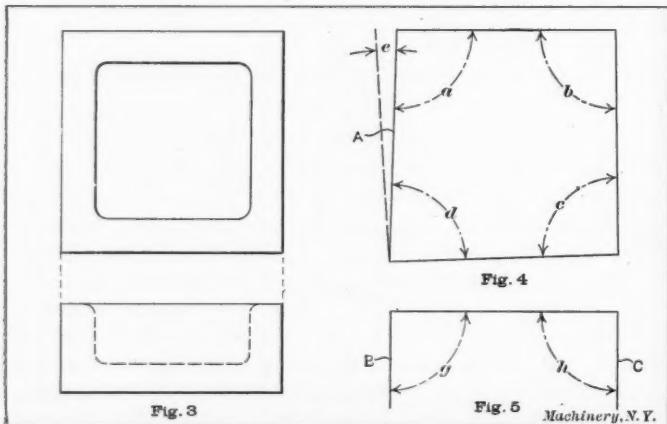
After planing, put one of the plates face up on a bench or box, where it can be gotten at from two opposite sides; then turn another plate on this one, with the faces together, and using benzine and No. 100 emery between them, proceed to grind or lap the plates together, keeping the surfaces wet with benzine. When they begin to bear all over, lay one aside and take a new plate; then lay aside the first plate and lap together the second and third, and proceed in this manner till all are finished. This, of course, is on the old principle that no three surfaces can all fit each other, unless all are true planes.

It is not at all necessary to use red lead or blue as a marking to indicate when the surfaces fit each other, as by wiping them clean with benzine and waste and standing off some ten or fifteen feet with the plate in a horizontal position between the eye and a window, it will be very easy to see where the bearing is, as of course there will be no small spots such as there are when two planes are being scraped together. The high places will appear to be highly polished, while parts which do not bear will appear dead and like ground glass. The finishing is done with the finest flour of emery, and very little of that. When the plates are new, they will warp and spring out of shape, and use will wear low places in them; they are then once more put through the lapping process with each other.

For spreading the emery and benzine and charging the

plates when in use, it is well to have a cast-iron charging block, measuring about 5 by 7 inches and 4 inches thick, with U-shaped handles on the top and one end. The face which is planed should have semicircular grooves, about  $\frac{1}{4}$  inch wide and about 1 inch apart, planed both ways to form squares. These grooves form air passages and prevent sticking, thereby facilitating the work. To charge, apply emery to the lap by shaking it from a box having small holes punched in the cover, and wet down with benzine from a common oil can; then rub the charging block over the surface from side to side, and, gradually working from end to end, cover the whole surface. This block is frequently used also to clean and sharpen the surface of the lap, when it is rubbed over simply with benzine. For finishing such work as we now have in hand, the charging block is rubbed over the lap with benzine only, and the lap is then wiped dry with waste, wiping from end to end only, and with the grooves, as in this way much less lint will be caught than if we try to wipe across them, or if the grooves were planed both ways. It is often convenient, in doing small work on a lap of this size, to have a little emery on one end and the other clean, so that both roughing and finishing may be done without waste of time.

Care should, of course, be exercised to distribute the wear as evenly as possible. In beginning to lap the parts of a square, benzine and flour of emery or carborundum are used till the wheel marks are out of the surfaces, while the finishing is done with the lap wiped perfectly dry and clean, the



Figs. 3 to 5. Test Block for Squares and Method of Developing a 90-degree Angle

emery bedded into the cast-iron lap being sufficient to cut and polish.

We will assume that the square, Fig. 2, has been finished and the blade and stock set as nearly square as possible by other means. To finish the test block, which is represented in Fig. 4, the side *A* is first lapped perfectly flat and used as a starter. By lapping we now fit the angle *a* to the square. The testing is done by carefully wiping the square and block surfaces with the bare hand or a piece of chamois, applying the square to the block, and holding them up to the eye before a strong light. When they fit together so closely as to shut out the light the whole length of the blade, angles *b* and *c* should be fitted in a similar manner. When this has been done and the square is applied to angle *d*, we may find, as in the sketch (which is greatly exaggerated for illustration), that there is a considerable space *e* between the outer end of the blade and the block, and this shows that the "square" is just one-fourth of this opening over 90 degrees, or, in other words, that the "square's" error is multiplied by four, as shown by this opening, on the last or final angle tried. Should the opening appear at the other end of the blade, it would merely mean that the angles were less than 90 degrees. In either case the blade should be reset an amount equal to one-fourth of the opening shown, as near as can be estimated, and the block is again fitted to the square, as before; this process is repeated as many times as may be necessary to shut out the light on all four corners, or angles.

By having the surfaces clean and dry and carefully applying the edge of the stock with the blade a little ways off, and

working it gently to get the air out, a good contact is obtained, and by gently working the blade down until it barely touches the block, a very accurate test can be made; for it seems to be pretty well known that under these conditions light may be seen through a space which is only one-forty-thousandth part of an inch wide. This will probably be as close to square as we care to go; but there is another method of testing that seems to admit of still greater refinement, which is as follows: After wiping the block as clean as possible with the bare hand, there will still remain on the surfaces a thin film of moisture. By gently moving to exclude the air, as before, bring the block and square stock into close contact, and then bring the blade to bear; when it does, give it a side-wise movement of about  $1/32$  inch. Upon removal, and in a good light, it will be seen that the blade has left a slight but distinct mark in the moisture upon the surface of the block. Unless this mark extends the full length of the blade, it shows that while it may have been close enough to shut out the light, it did not actually touch all over, and by careful work it may be made to do so. The color of this mark should also be noted, as it varies with the pressure between the edge and flat surface and is another guide to refinement. It should be uniform in appearance from end to end.

The outside or back edge of the square is left until the block is completed, when it is tested by standing both block and square on a true, flat surface and proceeding as before, except that the edge is now lapped with a small hand lap to bring it true instead of by moving the screws, as before; and, of course, the block is not lapped because it has been previously made square.

It is necessary, while finishing both edges of the blade, to tilt or roll it at an angle both ways over its slightly rounded edge, making it bear as shown by the dotted lines *a* and *b*, Fig. 1. Were this not done, the square might be anything but true if it were turned ever so slightly at an angle to the work. It is this rolling over and making the edge touch its full length in any position that takes the most time and patience. A tool of this kind is best made at odd times and worked in between other jobs, as it will not do to hurry it in the least, and neither the block nor the square can be held in the hand any length of time without being warped or expanded out of shape by the heat of the hand. If these operations be extended over several months or a year, at the end of that time the steel will become so settled as to stay in shape fairly well. For some time after the block is under way, it will be noticed that the corners fall away and the flat surfaces gradually become high in the center.

A quicker but somewhat less accurate way of testing a square is shown in Fig. 5. The piece is made parallel on its two sides *B* and *C* and the angle *g* is fitted, by scraping or lapping to the square. If the square be now applied to angle *h* the error, if any, will be multiplied by two instead of by four as in the other method. This last method has the further disadvantage of depending entirely on the parallelism of the two sides of the test block.

A rule that should be followed in squaring work is to hold the stock against the shortest side of the work, if there be one, whether or not that side is to be changed or corrected. In this way the angle of error, if there be one, between the work and the blade, is extended and much more readily seen than when the blade is applied to a short surface, such as the end of a bar.

\* \* \*

The metric standard taper shanks, dimensions of which were given in MACHINERY, September, 1907, engineering edition, have been adopted by the railway shops of the Prussian State railways. These taper shanks were some time ago recommended by the Society of German Machine Tool Builders. Some German machine tool builders opposed the introduction of the metric taper shank, or, as it is called in Germany, the "German taper," but the machine tool builders belonging to the society mentioned above supply German taper shanks on the tools they make at the same price as other standard taper shanks, facilitating the introduction of the new standard.

## RAPID WORK DONE ON THE AUTOMATIC SCREW MACHINE

From time to time operations performed on the Cleveland automatic screw machines, manufactured by the Cleveland Automatic Machine Co., Cleveland, Ohio, have been described in *MACHINERY*. (See the November, 1908, December, 1908, and April, 1910, numbers). These operations have been of interest to mechanics partly because of the ingenious methods used, and partly because of the rapidity with which the operations have been carried out. In the present article the method of making special knurled nut blanks is illustrated

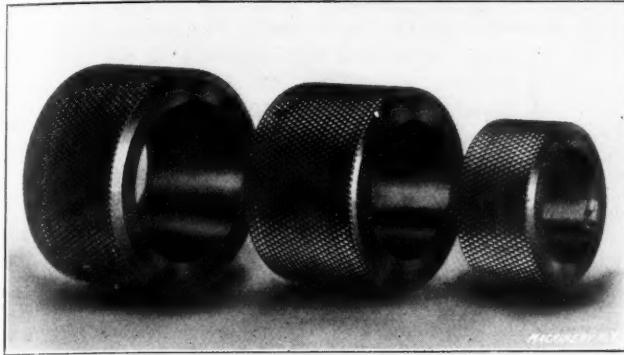


Fig. 1. Knurled Nut Blanks made at a Rapid Rate on the Cleveland Automatic Screw Machine

and described, the notable feature about the making of these nut blanks being the rapidity with which the work is completed.

In Fig. 1 are shown three sizes of nut blanks, all made in the same manner. The smallest one is  $1\frac{1}{8}$  inch outside diameter, 1 inch long, with a  $1\frac{1}{4}$ -inch hole drilled through it; the medium-sized nut is  $2\frac{1}{4}$  inches outside diameter,  $1\frac{1}{2}$  inch long, and has a  $1\frac{1}{2}$ -inch hole drilled through it; and the largest blank is  $2\frac{1}{2}$  inches outside diameter,  $1\frac{1}{2}$  inch long, and has a  $1\frac{3}{4}$ -inch hole drilled through it. The operations performed in the screw machine consist of drilling the hole in the blank, knurling it, chamfering the ends, and cutting off. The pieces are made at a very rapid rate by the methods to be described. Of the smallest size, 60 blanks are produced

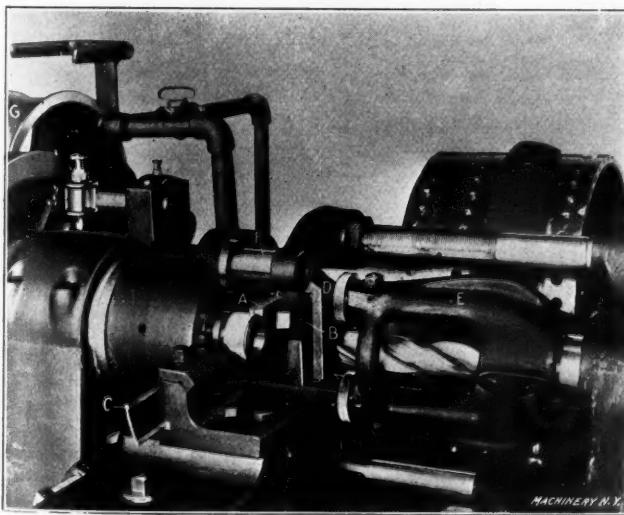


Fig. 2. Arrangement of Tools for Making Knurled Nut Blanks shown in Fig. 1

per hour, or one a minute. Of the medium size, 45 blanks are produced per hour, this being at the rate of 1 minute and 20 seconds a piece. Of the largest size, 36 blanks are produced per hour, or at the rate of 1 minute and 40 seconds a piece.

The halftone illustration, Fig. 2, shows the method and tools by means of which these results are accomplished. The tools used comprise a holder for the drills and knurls, tools *A* and *B* held in the rear toolpost, and cutting-off tool *C* in the front toolpost. The holder for the drills and knurls is shown at *E*. This holder is made from a steel casting, and is made of an open form so as to give ample space for the chips from the drilling operation. Owing to the rapidity with which the drilling is done, ample chip room is absolutely necessary.

The knurls *D* are simply round disk knurls, mounted on eccentric studs, which permits of adjustment of the knurls. The tools *A* and *B* are held in separate toolposts clamped to the rear cross-slide, and each of the tools can thus be adjusted independently of the other. Tool *B* faces off the front end of the nut blank and brings the piece to exact length, while tool *A*, acting simultaneously with tool *B*, chamfers the corners and partially cuts off the piece. When these operations are completed, the cutting-off tool instantly commences separating the piece from the bar. The drilling and knurling operations proceed simultaneously with the operation of tools *A* and *B*, so that no time whatever is lost in having any of the tools idle at any time during the operation on the piece. The drill is of the oil-tube type, permitting ample lubrication. At *F* is shown a swinging gage stop. The only special feature about the machine is the flanged pulley *G* employed in this case. This pulley can be removed in a few minutes and the regular driving mechanism put in its place.

An interesting feature in connection with this work is that only a year ago the company manufacturing the machine considered that  $3\frac{1}{2}$  minutes would be very satisfactory time for making the largest blank in the series, whereas now this blank is completed in less than one-half that time. Three years ago the time for work of this kind was estimated at 5 minutes. These figures are of particular interest to the mechanic as indicating the rapid advance that has been made in large automatic screw machine work in the last few years, and the possibilities which are open for improvement in the manufacture of duplicate parts at a rapid rate.

\* \* \*

## DRAWING AND JIG ORDER

The manufacture of shapers and gear-cutting machines in the shop of the Cincinnati Shaper Co. and the Cincinnati Gear-Cutting Machine Co. (under common management), is

CHECK NUMBER	DRAWING AND JIG ORDER			
	Piece No.	Sheet Drawing No.	Gauge No.	Shelf No.
Jig No.	Shelf No.	Gauge No.	Shelf No.	
Jig No.	Shelf No.	Gauge No.	Shelf No.	
Jig No.	Shelf No.	Gauge No.	Shelf No.	
Jig No.	Shelf No.	Gauge No.	Shelf No.	
Jig No.	Shelf No.	Gauge No.	Shelf No.	
Remarks				

A Drawing and Jig Order used in the Shops of the Cincinnati Shaper Co. and the Cincinnati Gear-Cutting Machine Co.

typical of the practice of the best machine-tool makers of Cincinnati and elsewhere, in that jigs and fixtures are provided for drilling, boring, planing, and otherwise machining all the parts. The low production cost and other benefits of interchangeable manufacturing thus resulting are not secured without some counteracting disadvantages, however. Where there are several types of machines built and several sizes of each type, the investment in these jigs and fixtures becomes very heavy, and the storing and caring for them so that any one can be readily found, is no small problem. Comprehensive storage and index systems are necessary if the best results are to be obtained.

The above reproduction of the "drawing and jig order," used by the before-mentioned concerns shows the form that is filled out when a workman is given a job. The foreman of his department writes the order, having a card-index system at his desk containing all the data required for the purpose. The order entitles the workman to the drawing, jigs and gages necessary for the job given him, and all the jigs and tools are delivered to his machine. This system is of somewhat greater complexity than that in which each jig is accompanied with the tools required for its use, but on the other hand there is less duplication of tools and, of course, less investment in the jig and fixture equipment.

## A PORTABLE CYLINDER BORING BAR

By PERCY W. LOCKWOOD\*

A few months ago when overhauling a large vertical twin-compound steam engine, it was noticed that the Corliss valves and their chambers were badly scored by the action of the steam, thus impairing the efficiency of the engine. It was decided to re-bore the chambers and make a new set of valves. The question then arose as to how this could best be done with the appliances available in the machine shop.

The engine formed one of a number of units in the power station attached to a large factory, and to remove the cylinders to the machine shop practically required the dismantling of the engine and its re-erection. Again, although the ma-

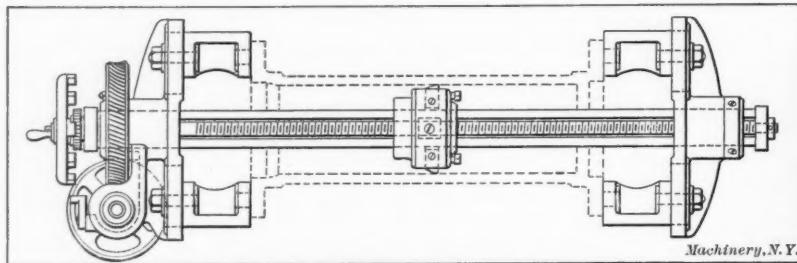


Fig. 1. General View of Portable Cylinder Boring Bar

chine shop is a large one and equipped with an unusual variety of modern machine tools, there was no boring mill suitable for the work and at the same time large enough to take these cylinders. Finally, a great risk would have been incurred by using the light cranes available, to handle such heavy castings.

Under these circumstances inquiries were made as to what manner of appliances were procurable for re-boring the valve casings with the cylinders still in place on the engine. A number of catalogues and circulars were received describing and illustrating various types of portable boring bars, but, owing to these being either too costly or unnecessarily elaborate for the requirements, or unsuitable for the work to be done, it was decided to make one. The accompanying illustrations give a general idea of the apparatus designed, and also show in detail how it was constructed.

Fig. 1 shows a general outside view of the tool with an imaginary cylinder (shown in dotted lines) in place between the heads. Fig. 2 is a sectional elevation showing the details of construction. Fig. 3 is a front elevation and Figs. 4 and 5 show further details of the tool-head. It was designed so that the bar could be driven by means of a small electric motor, for which there was ample room on the overhead starting platform between the cylinders.

All four valve chambers in the high-pressure cylinder had a 5-inch bore; in the low-pressure cylinder the two inlet valve chambers had a 7-inch bore, and the exhaust valve chambers, an 8-inch bore. Their respective lengths varied from 2 feet 9 inches to close to 4 feet. To provide for this range of diameters two sizes of tool-heads were made, one being  $4\frac{1}{4}$  inches in diameter, for the smallest size of chamber, and the other  $6\frac{1}{4}$  inches in diameter, for the two larger sizes. In the latter size of head only one set of tools was provided, and these tools were so designed that they could be adjusted and set to bore either size of chamber. In each case the work was completed in one roughing and one finishing cut, different sets of tools being used for each operation, the cutting speed in all operations being 45 feet per minute. This speed was maintained throughout by the simple expedient of changing the sizes of pulleys on the boring bar on the motor.

The apparatus comprises two bridge heads, the forward one, A, carrying the driving and feed mechanism, and the rear

feed-screw D and carries the tool-head E with the tools F and the feed-screw nut G. The drive is obtained by means of the head B constituting a guide bearing. The bar C contains the triple-threaded worm H, having 0.3 inch lead, and the cast-iron worm-wheel J which has 100 teeth.

The worm is somewhat too large in size and could with advantage be made smaller, so as to reduce friction and give more power, but in this instance it was made to suit the only triple-threaded hob in stock of approximately the required size, and, as there was only one wheel to be cut, it was not worth while making another hob. The feed is obtained by means of a five-point star wheel K (dished so as to cover and protect the small gear wheels) and the fixed pawl L. Once in each revolution of the bar C one of the points of the star wheel is brought into contact with the pawl, and the star wheel is thereby rotated in the opposite direction to that in which the bar revolves, until, by reason of its eccentricity in relation to the latter, it is enabled to slip past the pawl and resume its former motion with the bar C. Keyed to the hub of the star wheel, and running free on its spindle, is a pinion M of 21 teeth, meshing with a spur wheel N of 42 teeth which is keyed to the feed-screw D. The feed-screw is  $1\frac{1}{8}$  inch in diameter, and is provided with four left-hand threads per inch. Thus, with a ratio of 1 to 2 between the pinion and the gear, five points in the star wheel and a pitch of 0.25 inch in the feed-screw, we have a feed of  $1/40$  inch per revolution of bar C.

The star wheel is provided with a handle, so that, when the wheel is in a position clear of the pawl, the tool-head can be brought back by hand, after the completion of a cut. The distance pieces P placed between the bridge heads and the cylinder to be operated upon are designed so as to afford ample room for adjusting the tools in the head prior to or

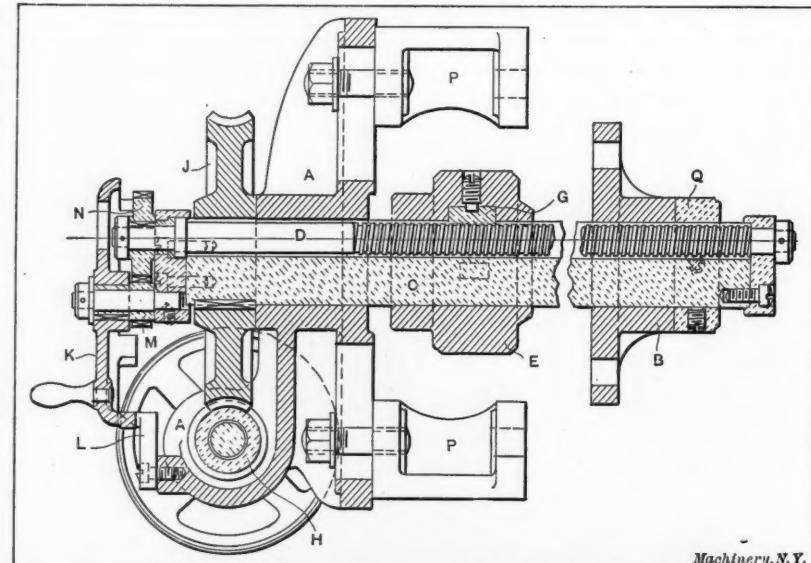


Fig. 2. Section of Device, showing Constructional Details

after making a cut. For boring out cylinders larger in diameter than the capacity of the bridge heads, these distance pieces can take the form of long beams, extending across the cylinder flanges, and a tool-head of a tee or coupling flange shape may be substituted for the one illustrated, so as to bring the tool support closer to the cylinder wall. A groove is milled out of the entire length of the bar C for receiving the feed-screw, and within which the feed-screw nut G is also guided and travels.

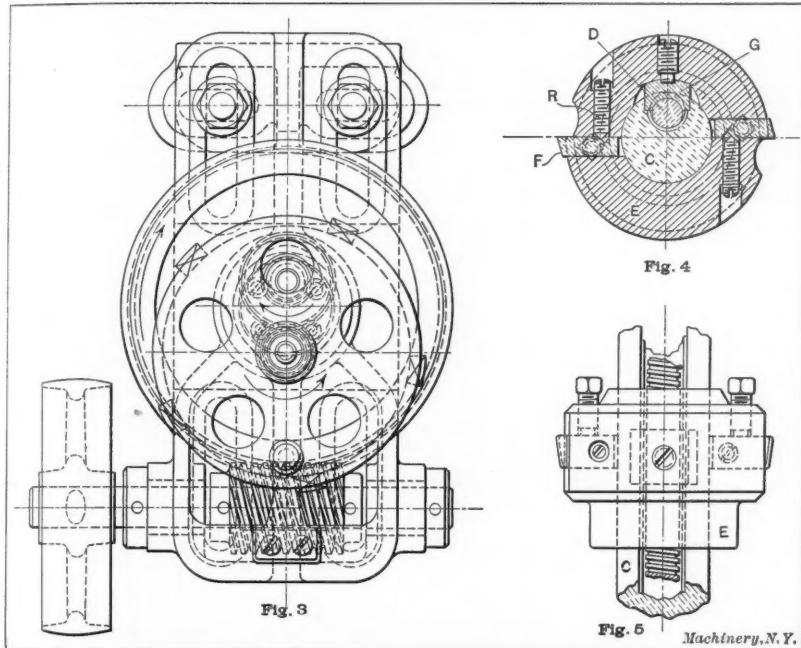
The feed-screw nut projects into the body of the tool-holder E, a portion of which is milled out to receive it. The arrangement of these parts constituted a very rigid, simple and compact device. The roughing tool only is shown in the illustrations, the finishing tool differing from it merely by having a short parallel cutting edge between the nose and the "backing-off."

The cutting tools F have each a conical countersink formed

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in their forward faces; these conical recesses have their centers situated closer to the bar than the adjusting screws *R* so that when the latter are screwed further into the tool-head, their points produce a lateral, outward adjustment of the tools *F*. The collar *Q* is provided with two set-screws so as to bind it to the bar in any position suited to the length of cylinder under operation.

An additional bearing bracket could also be provided on the forward bridge head *A* to carry a driving shaft placed at right angles to the worm-shaft and fitted with a pair of miter gears interposed between the shafts, so as to give a right-angle drive if desired. A modification of the rear bridge head *B* is shown in Fig. 2. The one illustrated here is de-



Figs. 3, 4 and 5. Front Elevation and Details of Tool-head

signed to suit the rear end of a pump chamber which usually has a smaller size of opening and flange than is provided at the cover end of the pump. The apparatus, in general, is peculiarly adapted for the re-boring of pump barrels in place on board ship, and obviates the usual necessity of dismantling the pump and taking it ashore to the repair shop, a lengthy process which very often causes delay in the sailing of the vessel.

\* \* \*

#### MAKING PACKING BOXES

The general custom of packing small tools and hardware is to use stock-size packing cases and to select the size for the shipment that will contain the goods with the least amount of waste room. The practice of the Armstrong Bros. Tool Co. of Chicago, however, is to make up boxes for each shipment as near the required size as possible. The reason is to insure the goods being received with the individual strawboard cartons, in which each tool is packed, in good condition. This is an important consideration in the case of hardware shelf goods which must present a good appearance to the customers.

The orders are filled by gathering together all the items for a shipment on a sheet-steel table, arranging them to best suit the size and number of the individual cartons. When these have been grouped to the satisfaction of the packer, the three dimensions of the pile are measured and a box is made of these inside dimensions, in the box department immediately adjoining the shipping department. The box thus made, while more costly than a stock box, fits the shipment and carries it to its destination with a minimum of damage to the cases. Special care is taken to protect the tools from dampness, each tool being wrapped individually before being packed in its carton, the entire shipment then being enclosed in oiled paper within the packing case.

#### SPECIAL DRILLS AND REAMERS

By JAMES H. CARVER\*

A number of special drills and reamers of different designs are illustrated in Figs. 1 to 14. These tools cannot be classified as standard types, but some of them have been widely used for special purposes and the various designs may prove of value to those engaged on work requiring special equipment.

In Fig. 1 is shown a tool that is known as a "hog-nose" reamer. This tool is used for enlarging a hole, cored or otherwise, and it is employed extensively in ordnance work for roughing out the steel forgings, jackets, tubes, etc., that are

required in the construction of coast-defence mortars and rifles. A reamer of this type, when mounted on the boring-bar of a gun lathe, will bore the entire length of a tube. It may also be used to advantage in the lathe, on much smaller work. When this reamer is made in large sizes, a cast-iron body is used, whereas for comparatively small work the body is made of machine or cold-rolled steel. The copper oil tube shown may, of course, be omitted when the reamer is to be used on cast iron.

A finishing reamer designed to follow the "hog-nose" reamer is shown in Fig. 2. The body of this reamer is also made of cast iron for large work, and either machine or cold-rolled steel is used for smaller sizes. The reamer has two semi-circular wooden pieces of oil-soaked maple fastened to each side as shown. On the large reamers these pieces are attached by bolts, and on small sizes button-head screws that tap into the body are used. When this reamer is in use, the wooden pieces, which are a close-working fit in the finished hole, push the chips ahead as the reamer advances. The two cutters used are backed off and stoned on lathe centers before the wooden blocks are turned. The tool used for turning these blocks is set a trifle over the reamer size by placing a piece of tissue paper between it and the cutters. In case these blocks need re-turning, they are first shimmed by the use of thin wooden strips.

Fig. 3 shows a reamer that is used for finishing a spherical surface at the bottom of a hole. The bronze semicircular pieces *B* attached to the pilot, prevent it from seizing or cutting, as it is likely to do when steel is used. The work is indicated by the dotted lines, and both the large and small holes are, of course, finished before using this reamer.

A roughing and finishing reamer for brass work is shown in Fig. 4, the only change for roughing or finishing being in the clearance given the cutting edge. This is an efficient tool on brass, and it is good for diameters up to about 6 inches, and lengths of, say, 20 inches. The body is a piece of flat steel, which is turned about 1/32 inch below the size, nearly to the cutting edge, as shown by the dotted lines. The wooden guide blocks are held by round- or fillister-head screws.

An all-metal cutter of the hog-nose type, much used in gun shops when a square bottomed hole is necessary, is shown in Fig. 5. As nearly one-half the body of the tool is cut away, there is plenty of room for the chips. This cutter is made in the milling machine, and is ground after the hardening operation.

Fig. 6 shows a hollow drill that is used for cutting test pieces from the interior of a solid piece of metal. The piece secured in this way, which is, say, about 1 1/8 inch in diameter and 9 inches in length, is turned down to 1 inch in diameter in the middle, thus leaving enlarged ends for gripping, when the tests are being made. This tool will not work very well with a body that is less than three-quarters of the circumference, and it cannot be forced much when used on steel. As obtaining test pieces is rather a rough job, the body of the tool need not be ground unless it is distorted in hardening.

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The reamer shown in Fig. 7 is a type used when putting in primer seats in the breech ends of mortars and rifles. The cutting edge at the chamfer is the only part that does any cutting. The hole is drilled and reamed before using this tool which simply finishes the bottom tapering. This style of reamer is used chiefly on small work.

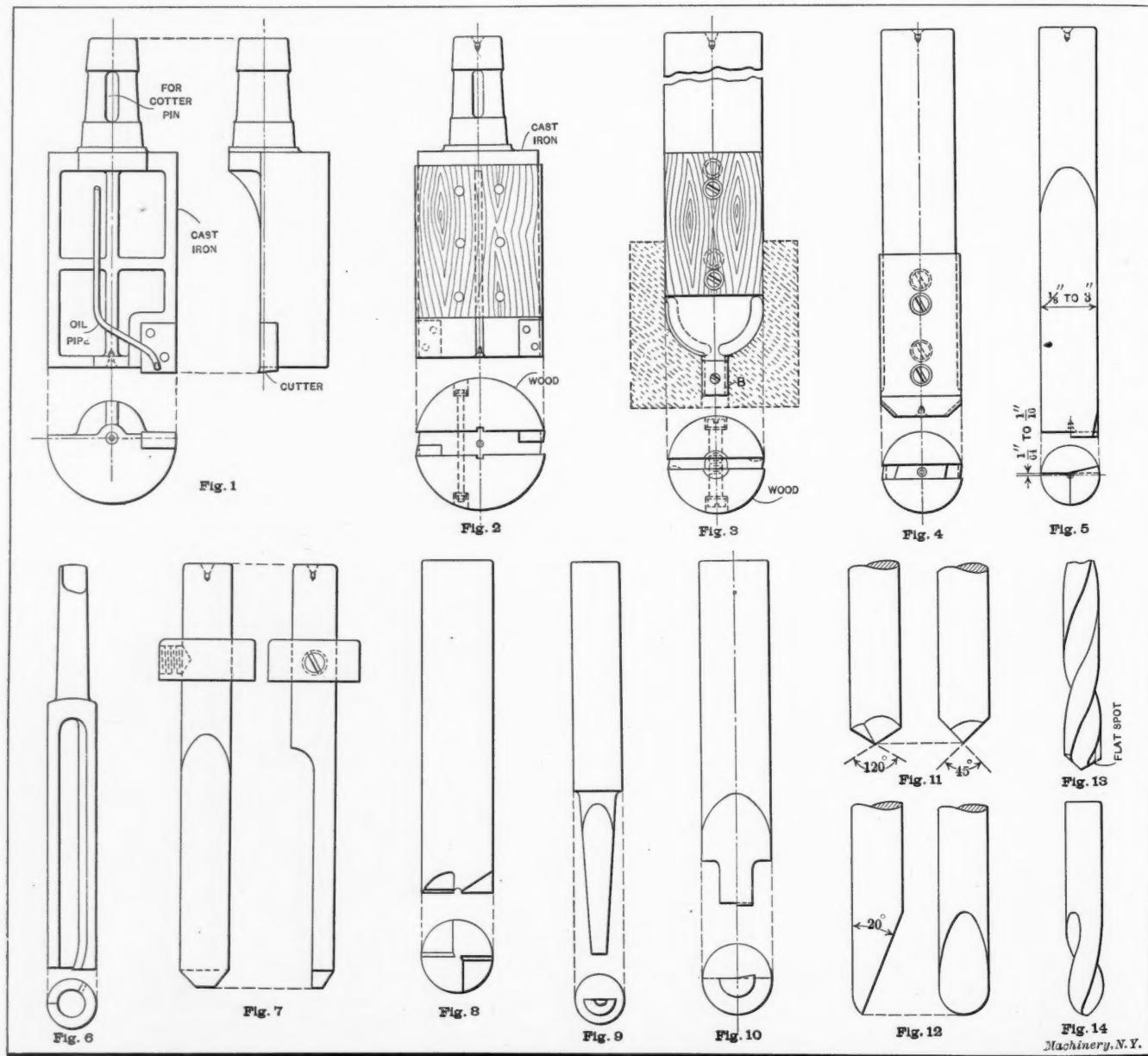
Fig. 8 shows a drill that is made from drill rod by filing square cutting edges as shown, and it is used for squaring up the bottoms of small holes of odd sizes. A taper reamer that is also made from drill rod is shown in Fig. 9. This tool is much used on drop-forged dies, in which small taper holes are often needed for projections in the finished work, such as parts to be riveted, etc. Another useful tool for drop-forged work, that is made from drill rod is shown in Fig. 10. A little

In Fig. 13 the old "stunt" of giving an ordinary twist drill negative clearance or back slope on the hook or lip of the drill, is illustrated. A twist drill ground in this way does not tend to "pull in" when drilling brass.

A form of cutter much used by die-sinkers either in a vertical miller or die-sinking machine, is shown in Fig. 14. This tool is known as a "router," and it is made from a regular twist drill. The router is very useful for cutting out corners in dies, cutting sprues, and for other work where there is considerable metal to be removed.

\* \* \*

The Poldi Steel Works of Sheffield, England, have placed a quality of steel on the market which is intended especially for the manufacture of rifle barrels, and which has remarkable



Figs. 1 to 14. Showing Various Styles of Special Drills and Reamers

over half of the rod is milled or filed away and the reduced cutting end is given clearance as shown. A transfer drill, much used on die work for transferring holes from the dies to the stripper-plate, is shown in Fig. 11. This drill is also made from drill rod and it is given a very blunt cutting angle as shown. It is merely used to spot centers for a regular drill by using the holes in the die as a guide. Fig. 12 shows a reamer that can be made from any size of drill rod by simply filing the end at an angle as shown. This tool is used to ream thin stock and it has an advantage over other styles in that it does not cut over size, the diameter of the reamed hole being practically the same as that of the drill rod used for making the reamer. A drill is, of course, used first, and only a few thousandths should be left for reaming.

non-corrosive properties. It is stated that the steel also resists the action of acids, and can be used to advantage for the manufacture of pump shafts, valve spindles and seats, check-rings for valves, plug valves, etc. The rust-proof tests were made, according to *Engineering*, with barrels fired with smokeless powder five times a day, at intervals of ten days, the tests lasting over a period of fifty days. The barrels were meanwhile kept in a damp cellar and never cleaned, but did not reveal the formation of any rust. The steel has a high tensile strength, the ultimate strength being about 127,000 pounds per square inch and the elastic limit 108,000 pounds per square inch. The elongation in two inches is 25 per cent. The steel can be machined without any particular difficulty, provided a good sharp cutting tool is used.

## EXTERNAL CUTTING TOOLS—3

## PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON\*

In the present instalment, examples of various designs of box-tools, swing tools for external work, and taper-turning tools are described.

## Designing Box-tools

The designer of screw-machine tools is frequently confronted with difficulties when designing special box-tools, owing to the fact that the Brown & Sharpe automatic screw machines are very compact. This makes it necessary to design all the tools so that they will not interfere with any part of the machine or the tools which are used on the cross-slides. The following considerations must also be borne in mind:

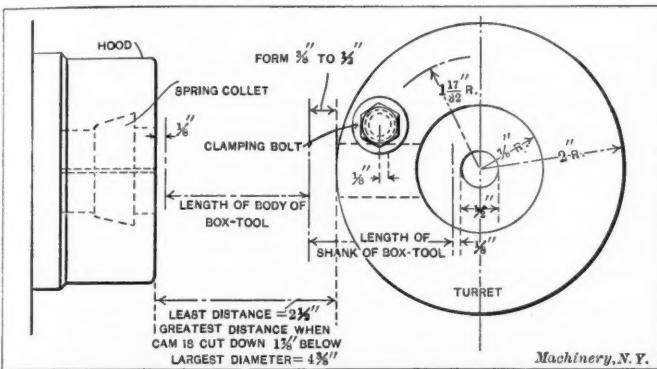


Fig. 8. Method of Determining Length of Body and Shank of Box-tool

1. Character of material, whether rough or cold-drawn;
2. Cross-section of the material, whether cylindrical, square, or hexagonal, etc.;
3. Character of the longitudinal cut, whether straight, tapered or irregular;
4. Length of the work to be turned;
5. Number of different diameters to be turned;
6. Position of the box-tool in relation to the cross-slide tools, when in action on the work;
7. Amount of material to be removed from the diameter.

In addition to the factors mentioned, one of the first things to consider when designing a box-tool, is the length of the body and shank of the tool. As a rule, the length of the body is governed by the length of the work to be turned, especially when the hole in the shank cannot be made large enough to let the smallest diameter of the work pass through. Another consideration to take into account, is the distance from the

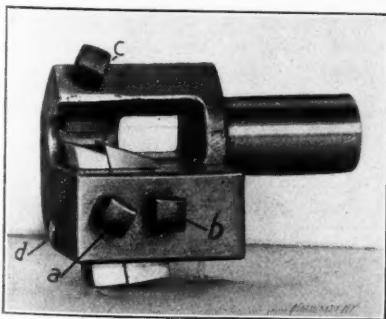


Fig. 9. Standard Box-tool made by the Brown & Sharpe Mfg. Co.

$\frac{1}{8}$  inch it is usually necessary to have the cutter project slightly in advance of the face of the box-tool body.

If a special box-tool is to be designed, it is advisable to make a layout of the machine on which this tool is to be used. A plan and side elevation of the turret and cross-slides should be drawn, and the tools used on the cross-slide should also be drawn in the positions they will occupy when the box-tool is in operation on the work.

A method of laying out a box-tool for determining the length of the body and shank is shown in Fig. 8. This diagram is for a No. 0 machine, but the same principle can be used for the other sizes. When designing a standard box-

tool, the body is made about  $\frac{5}{8}$  inch less than the least distance between the face of the turret and the face of the chuck. The shank is allowed to project through the turret to within  $\frac{1}{8}$  inch of the  $\frac{1}{2}$ -inch hole through the turret spindle. All the other important points regarding the design and uses of supports, turning-tool holders, etc., have been previously described, so it will not be necessary to enlarge on them here.

### Various Types of Box-tools

As there are so many designs of box-tools in use, it will be impossible to mention all of them, but a few of the most

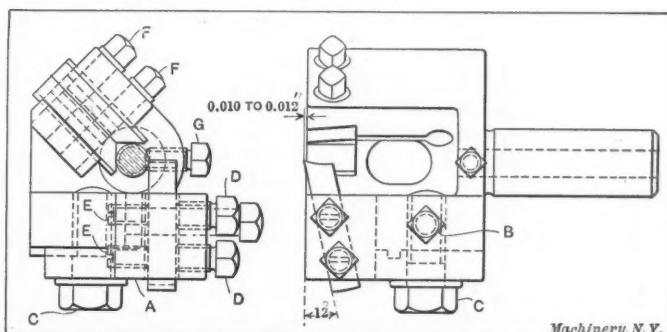


Fig. 10. Finishing Box-tool largely used for Steel Work

common designs will be described. In Fig. 9 is shown a standard box-tool, as made by the Brown & Sharpe Mfg. Co. This box-tool, as shown, carries two cutting tools. The cutting tools rest on a pin *d* and are held by set-screws *a* and *b*, and by two other set-screws, not shown, which are on the under side of the box-tool. The support, which is of the V-type, is located at the back of the box-tool at an angle of 45 degrees with the vertical center line, and is held by the set-screw *c*. This box-tool is used for general work, for turning both one and two diameters, as required. When one diameter is being turned, the cutter in the rear is pushed back out of

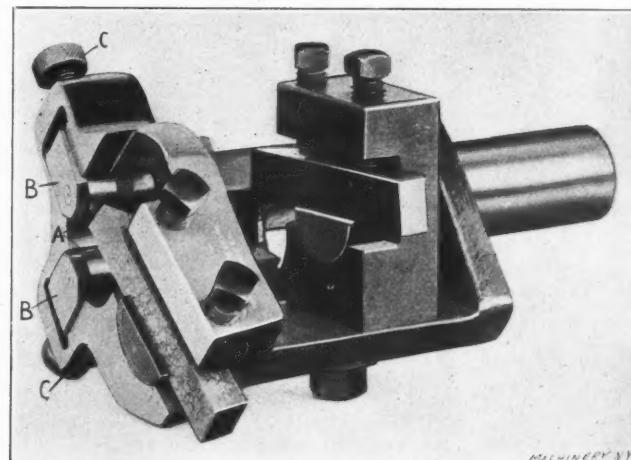


Fig. 11. Box-tool of the Roller Support Type

action. The method of determining the thickness of these cutters was illustrated in the first installment of this article.

In Fig. 10 is shown a standard finishing box-tool which is used largely for steel work. In this box-tool the turning tool is held in an adjustable block *A* which is adjusted up and down on the body of the holder by the set-screw *B*, and held to the body by the cap-screw *C*. A projection is formed on the body of the box-tool and a corresponding groove is cut in the block to guide it in a perpendicular position. The turning tool is held by means of two set-screws *D* and the headless screws *E* in the block *A*. The headless screws *E* are for adjusting the turning tool, in order to increase the clearance between the tool and the periphery of the work.

The V-support is held in beveled grooves cut in the body of the holder, by two screws *F* which pass through the two parts of the body binding them together. A slot is cut in the body to facilitate the drawing of the two parts together. The cutting edge of the turning tool is located from 0.010 to 0.012 inch in advance of the face of the supports. A hole is drilled through the shank of the box-tool for holding a pointing tool.

\* Associate Editor of **MACHINERY.**

or other internal cutting tool, which is held with the set-screw *G*.

The value of roller supports for turning aluminum, cast iron, etc., was previously mentioned, and in Fig. 11 is shown a box-tool of the roller-support type, as made by the Brown & Sharpe Mfg. Co. This box-tool, as may be seen, is provided with roller supports for the front cutter, and V-supports for the rear cutter.

The general design of this box-tool can be seen from a study of the illustration Fig. 11, but a clearer view of its construction

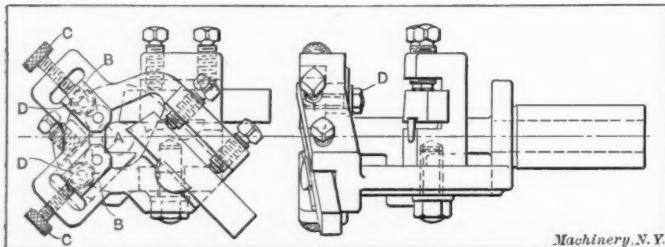


Fig. 12. Details of Box-tool shown in Fig. 11

is shown in Fig. 12. This illustration shows the method of holding and adjusting the roller supports. The supports *A* are held by pins in a slot cut in the two blocks *B*, which are adjusted in and out by the knurled-head screws *C*. The blocks *B* are held to the body of the box-tool by cap-screws *D* which are tapped into them. A slot is provided in the body of the holder in which the bodies of the cap-screws slide, thus

centering tool, the bushing for which is shown at *H*. *I* is a pointing tool of a somewhat similar design to that shown at *G*. *J* and *K* are also pointing tools which are used largely for small work. These illustrations show clearly the design of box-tools which are used, in general, for automatic screw machine work.

#### Swing Tools for External Work

Swing tools, besides being used extensively for internal cutting, are also used for external work. There are some cases where a box-tool or a circular form tool cannot be used, owing to the irregular contour and the length of the work in proportion to its diameter. Of course it is obvious that a form tool can be used where the length of the work being turned is not more than from  $2\frac{1}{2}$  to 3 times its diameter, but where it exceeds this amount it is necessary to use some other type. For this class of work, a swing tool such as that shown in Fig. 14 can be used to advantage. The work can be roughed down with this tool and finished with a shaving tool, which will bring it to the correct shape, and also to the desired diameter. (The use of shaving tools will be taken up in a subsequent article.) This tool, of course, can only be used when the diameter of the work is large enough to make a support unnecessary.

There are some cases, however, where the work being turned must be supported, especially where it is small in diameter in proportion to its length. A tool which gives very satisfactory results for this class of work is shown in Fig. 15. This tool is provided with a telescopic support which recedes

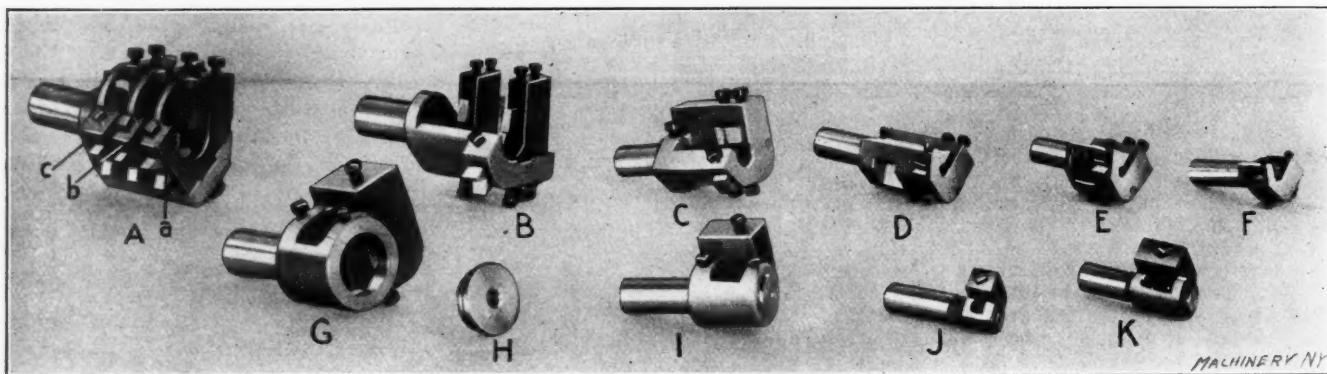


Fig. 13. A Collection of Interesting Designs of Box-tools

making provision for turning different diameters. All the other details of this box-tool can be clearly seen from the illustration.

Some interesting designs of box-tools are shown in Fig. 13. These tools are all the product of the Brown & Sharpe Mfg. Co. and are used for various classes of work. At *A* is shown a box-tool which is equipped with three turning tools, and three sets of V-supports. The turning-tool and V-support holders *a*, *b* and *c* are made in one piece and are held to the body of the box-tool by cap-screws. A tongue is formed on the base of the holders *a*, *b* and *c*, which fits in a longitudinal groove cut in the box-tool body. It will be noticed that the supports in this case are double supports, that is, they are notched on both ends, the purpose of this being to increase their range. The end of the support shown facing the turning tool is for work of small diameter, while the end projecting from the box-tool is for work of a larger diameter. This box-tool can be used either for roughing or for finishing work, and it is especially adaptable to work having three different diameters.

At *B* is shown a box-tool with two cutting tools, but with only one support. It will be noticed in this case that the holders for the turning tools are very narrow, thus permitting the tools to be set close together. The box-tool shown at *C* has two turning tools which are set close together. A hole is drilled through the shank, and a set-screw is provided for holding a centering or other internal cutting tool. At *D* is another box-tool similar to that shown at *C*, except that the supports in this case are double-ended. *E* is a finishing box-tool having two turning tools. *F* is a box-tool of similar design, but carrying only one turning tool. *G* is a pointing and

into the holder as the tool advances on the work. The other features of this tool are similar in design to the standard swing tools, so it will not be necessary to describe them. Mention might be made, however, of the method of holding the telescopic support *A*. A sleeve *B* is driven into the body and shank of the holder *C*, and held by the headless screw *D*. The support proper is turned down on the shank, so that an open-wound coil spring can be inserted behind it. The

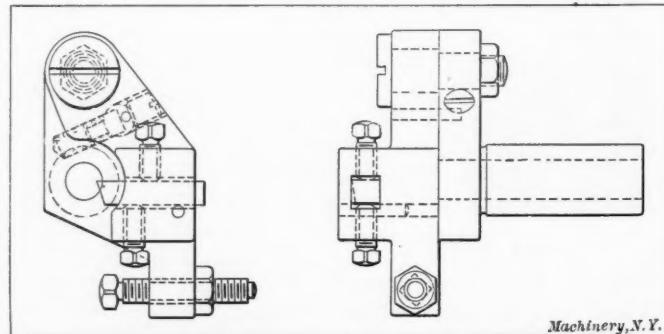


Fig. 14. Swing-tool used for External Cutting

support is kept from being forced out of the holder by a screw *E*, which is tapped into it, and which has a head larger than the hole through the end of the sleeve *B*. This method of supporting the work is found to give satisfactory results when turning work of very small diameter. It is preferable when using this tool to point the end of the work so that it fits snugly in the cone-pointed hole in the end of the support. A similar tool for delicate turning was illustrated and described in the June, 1908, number of *MACHINERY*.

## Taper Turning

Thus far we have confined our attention to tools used for straight turning; but of course taper work can also be accomplished on the automatic screw machine if a suitable tool is provided. A tool which can be used for taper turning is shown in Fig. 16. This is the standard taper turning tool made by the Brown & Sharpe Mfg. Co. and is recommended for taper turning where accurate work is desired. The illus-

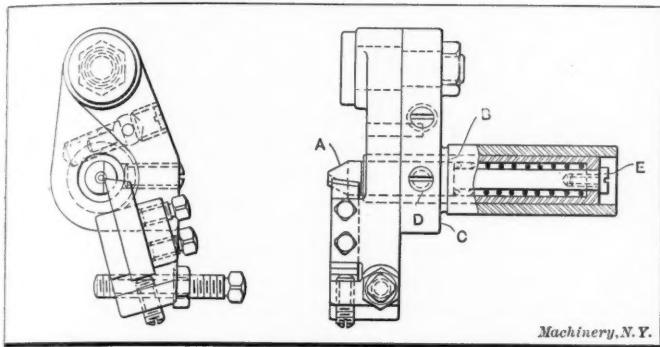


Fig. 15. Swing-tool used when the Work Turned must be supported

tration shows the taper turning tool and the rising block for operating it. This rising block is similar to that previously described, and can be set at any desired angle. The angle to which the rising block is set, governs the taper on the work. When in operation, this rising block presses on the point of the screw *a*, which, in turn, forces the holders carrying the supports and turning tool out from the center.

A clearer idea of the operation of this taper turning tool can be obtained by referring to Fig. 17. In this illustration an end view, longitudinal-section and cross-section are shown at *A*, *B* and *C*, respectively, to illustrate the working mechanism of this tool. As the rising block (shown in Fig. 16) presses against the point of the screw *a*, which is tapped into the sleeve *b*, it forces the latter in the direction of the arrow. Now as the sleeve *b* is forced in, it pulls on the band spring *c*, which is attached to the circular block *d*, thus turning the latter around in the direction of the arrow. The band spring is made from sheet steel, 5/16 inch wide by 0.012 inch thick, which is left soft. This spring, as shown, is fastened in a slot cut in the circular block *d*. The circular block *d* has eccentric projections *e* formed on it, which fit in slots cut in the tool-holder *f* and support-holders *g*. From a study of the illustration it can be seen that as the sleeve *b* is forced in, it carries the

tool can be adjusted independently of each other by the set-screws *h*, and are held by the fillister screws *i*. After the turret drops back, disconnecting the screw *a* with the rising block, the turning tool and supports are returned to their former position by means of the coil spring *j* (shown at *B*) which is held in an annular groove cut in the rear of the circular block *d*. The spring *j* presses against a pin *k* (shown at *C*) which is riveted to a plate *l*; this plate is held to the shank of the holder by a pin fitting in a slot. The plate *l* is held up against the outer casing of the holder by the nut *m*, screwed onto the shank of the holder. All the other details of this tool can be clearly seen from the illustration.

\* \* \*

## ELEMENTARY MATHEMATICS

The simple mathematics of percentage seems to be a stumbling block for some of the young advertising sharps. One not long ago claimed a reduction of cost of five hundred per cent, blissfully unconscious of the fact that the greatest possible saving could be only one hundred per cent, and that saving would require the cost to be absolutely nothing. Another was too modest in his claim. A farm produced seventeen bushels of wheat per acre while the adjoining farm produced sixty-one bushels—"a gain of seventy-two per cent." As a matter of fact the gain was two-hundred-fifty-nine per cent. If these young men who have forgotten some of their common arithmetic training will remember that the elements of percentage are: the *base*, the *per cent*, the *percentage*, and the *amount* or *difference* and will determine what is the base in all problems, no perplexity need result. In the case of the sav-

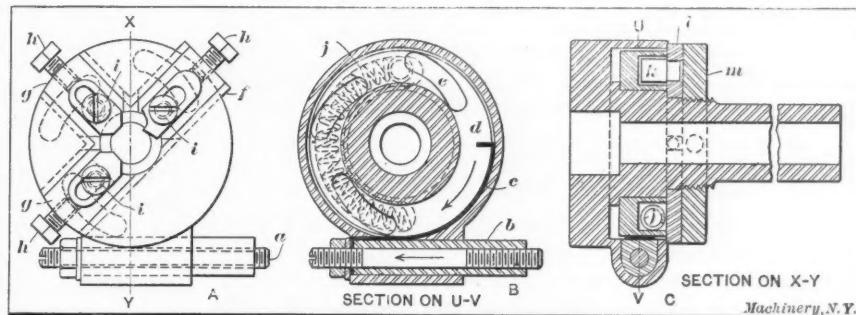


Fig. 17. Details of Taper Turning Tool shown in Fig. 16

ing, the original cost was the base. The production was increased five times or five hundred per cent, it is true, but the cost was cut four-fifths, and four-fifths of one-hundred per cent is eighty per cent. In the other case the base was the yield per acre of the poor farm. The difference between the yield of the poor farm and that of the good farm was forty-four bushels per acre, and as this gain is to be expressed in percentage of the lesser yield, the latter must be the base for calculation.

\* \* \*

## TESTS OF BEARINGS AND JOURNALS

Two years ago the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio, made a comparative test of bearings for lathe spindles on two of the engine lathes in its plant, to determine the relative durability of the following combinations, *viz*: hardened steel journal in cast-iron box; hardened steel journal in bronze; soft steel journal in bronze; and soft steel journal in babbitt. The experiment was made on both ends of the spindles, thus making the four combinations named. Both lathes were kept in constant use, the general character of work being the same for both. When examined recently, the condition of the hardened steel journal and cast-iron box was the best of all, neither the spindle nor the box being appreciably worn, the grinder and scraper markings still being visible. The hardened steel journal and bronze box combination was in good shape, but the journal was slightly ridged in the center, showing more wear than the first. The soft spindle in bronze was worn appreciably, but the soft spindle in babbitt was in first-class condition. The bearings were provided with oil rings and oil reservoirs, and the main bearings with oil reservoirs and felt wicks.

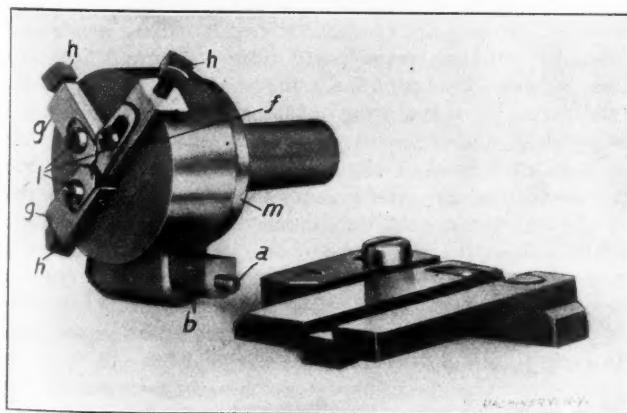


Fig. 16. Standard Taper Turning Tool

spring *c* forward, which rotates the circular block *d* in the direction of the arrow, thus forcing the holders carrying the supports and turning tools out from the center. This, as can be seen, will produce a taper on the work, the extent of which will depend on the angle to which the rising block is set.

In the end view shown at *A* the turning tool and support holders are shown in the position they occupy before the rising block operates on the holder. The supports and turning

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Entered at the Post-Office in New York City as Second-Class Mail Matter

# MACHINERY

DESIGN—CONSTRUCTION—OPERATION

PUBLISHED MONTHLY BY

THE INDUSTRIAL PRESS

49-55 LAFAYETTE STREET, CORNER OF LEONARD  
NEW YORK CITY

Alexander Luchars, President and Treasurer

Matthew J. O'Neill, Secretary

Fred E. Rogers, Editor.

Erik Oberg, Franklin D. Jones, Douglas T. Hamilton,

Fred. H. Moody,

Associate Editors

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on.

MARCH, 1911

PAID CIRCULATION FOR FEBRUARY, 1911, 26,164 COPIES

MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, \$1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—\$2.00 a year, coated paper \$2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, \$3.00 a year, comprises the same matter as the Engineering. The Railway Edition, \$2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

## PLANNING A MACHINE SHOP

The tendency of manufacturers when planning new shops and factories has been to lay out the buildings in accordance with certain ideals or notions, and to arrange the machinery and routing of work to conform to the buildings. In some cases, of course, the economical utilization of the available land makes this course to a large degree necessary, but where land is cheap a better plan can be followed.

The proposition can be treated almost entirely with reference to the logical arrangement of the machines for performing the operations on the product to be built, grouping them so that the raw material may enter the plant at one point and the finished product pass out at another, without retracing its course at any point. If the product consists of light and heavy machines of the same general type, they may be carried through in parallel lines, all arriving at a common destination. The planning of the building is then simply a problem of housing or roofing over a machine shop whose preliminary arrangement has been laid down on a certain sized lot. The saw-tooth roof building harmonizes with this conception admirably, and has been utilized with marked success by several machine tool builders in the Cincinnati district.

\* \* \*

## THE CAMERA IN THE SHOP

Some machine tool builders make very effective use of the camera in the shop by securing photographs, whenever there is an opportunity, that will illustrate the capability and capacity of their tools; and this practice could be extended with good results to other kinds of machinery and tools. Views of a machine at work indicate in many instances important features that are not apparent from an illustration of the idle machine, and they are also of value in showing the adaptability of a tool for handling various classes of work. The power of a tool and its probable output can be demonstrated by views showing the possibilities in the way of roughing cuts, etc. The output of the machine per hour per day, when shown by a picture, is also a very effective way of indicating its efficiency, and is more impressive than mere figures.

To obtain pictures of this kind without considerable inconvenience, a shop should have proper facilities for doing photographic work, so that the views can be secured whenever there is an opportunity. It is the practice of at least one machine tool builder to photograph his machines whenever they are engaged on different classes of work of an interesting nature. The plates thus obtained are filed in a cabinet that is kept in a room especially fitted up for photographic work. When an inquiry is received regarding the best method of machining a certain part, a picture is often available from the file that will show a machine actually engaged on work that is similar or perhaps identical with that referred to in the inquiry; and in this way the camera is made an important member of the sales department. These views are also used to advantage for illustrating catalogues or pamphlets, and in various other ways. The principal value of pictures of this kind would doubtless be found in connection with the introduction of comparatively new lines of work. When a machine tool builder enters a new field and endeavors to show the superiority of a method or machine, as applied to a certain class of work, he always encounters more or less indifference to any change in existing manufacturing methods. This was the experience of the pioneers in the milling machine field, and the manufacturers of grinding machines and other modern tools have had the same difficulty. Doubtless similar conditions exist in other lines where machinery is used; and a somewhat extensive use of the camera along the lines suggested would accomplish much toward encouraging the use of the most efficient methods and tools.

\* \* \*

## THE MILLING MACHINE AND THE GRINDER

A few years ago a great deal was said and written about the future of the milling machine, and some enthusiastic advocates of this tool predicted that it would usurp the place of the planer in the machine shop. But as time went on it became pretty well settled that each machine had a distinct field, not perhaps definitely limited within given boundaries, but nevertheless of such a character as to assure to each machine a permanent place in machine shop practice.

Some remarkable developments in the art of grinding have recently brought forth the suggestion that the grinding machine, properly designed and equipped, may in the future supersede the milling machine for plain finishing operations. To a certain extent this change probably will take place, but it will not make the milling machine superfluous nor less valuable. The development of the grinder along such lines as will make it efficient as a finishing machine for plain surfaces will, if anything, increase the value of the milling machine, because the latter machine is far more productive as a roughing than as a finishing tool; and its total efficiency will be increased if it can be relieved from performing finishing operations. Hence the development of the grinder will not be detrimental to the future of the milling machine. Each has plainly its distinct field, and there are operations suited to each which cannot be performed as economically, if at all, on the other; but it seems that the development of each will tend to increase the relative efficiency of both, much the same as the development of the cylindrical grinder has increased the efficiency of the lathe, and the use of high-speed steel for roughing has increased the total efficiency of the lathe and grinder combined, in a ratio which no one dreamed of ten or fifteen years ago.

In general, new developments in any field have the tendency to merely increase the efficiency of the tools, methods, or operators they are at first expected to replace. The sewing machine did not eliminate the workers at the tailor's trade, nor reduce their number; it merely increased their efficiency, cheapened the cost of production and therefore stimulated the demand. The advent of the steam locomotive did not decrease the number of people engaged in transportation—the number increased. Nor will the improved grinder lessen the demand for milling machines. The demand will increase, because the improvement is but another step in the progress towards increased production at less expenditure of labor, and all such advances increase the usefulness of machinery in general.

## DEFECTIVE METHODS OF ACQUIRING FOREIGN TRADE

Foreign merchants complain a good deal of the lack of attention of American manufacturers to the requirements of the buyer, and many thousand dollars' worth of orders have been lost through inattention to details in the inquiry. Not long ago an American manufacturer was requested to quote prices for his products delivered freight prepaid at a German port; but he replied quoting prices F. O. B. New York, and stating that it was impossible to quote prices in the form requested. It would have been very little trouble to find out the freight charges from New York to almost any European city—especially to one where there is direct steamer communication; and ordinary business judgment would have suggested taking the trouble necessary in this instance. Another case which we had occasion to mention in *MACHINERY* some time ago, referred to a request for a complete price list to be sent with the catalogue of the machinery inquired for; instead of sending the price list the catalogue was accompanied with a letter stating that prices would be quoted on application. The neglect to comply with this simple request meant the loss of an order amounting to nearly \$75,000.

Most of the troubles which arise with foreign buyers come from neglect to observe small requirements which would take very little time here, but represent a great deal of trouble on the other side if they are not attended to. Those of our manufacturers who are familiar with European methods comply with these requests, and their business moves along smoothly. Those who do not attend to them are generally new comers in the foreign field.

\* \* \*

## WORM VS. CHAIN DRIVE FOR AUTO TRUCKS

The compactness and simplicity of the worm gear are generally attractive to mechanical engineers and designers, and many have been led against their better judgment to use it in devices for which it is not suitable. Of all ordinary transmission mechanisms the worm gear requires the best workmanship, both in making and in mounting, to secure maximum efficiency; and even when everything possible has been done to make for the best efficiency, it is still relatively low. When high speed ratios are required in small space, in devices with few parts, or the self-locking feature is important, the worm is the ideal transmission to use, but if other transmission gear of high efficiency and durability can be used, why use something inferior?

A movement in the design of motor trucks to be deprecated is toward the use of the worm drive in the transmission to the rear axle, a worm and wormwheel taking the place of bevel gears. We believe the move will be disastrous if generally followed by the builders of motor trucks, because reliability is required first of all in cars for commercial uses. Neatness of outline and freedom from noise are prime considerations in pleasure cars, but it appears like poor design to employ a rear axle in a heavy truck containing the differential and a worm drive, in place of the plain axle and a parallel lay shaft carrying the differential and chain sprockets for the intermediate transmission to the wheels. The latter form of drive is easily repaired; drivers can make shift to get along if one side is badly damaged, and are doing it every day. Hooking the rear wheel into an obstruction with force sufficient to bend the axle does not necessarily put the truck out of running, but it surely would if furnished with the worm drive and differential in the axle. Another disadvantage of the latter is the greater dead weight—that is, weight not spring supported—carried on the rear wheels as compared with the load carried by the differential rear axle type. The chain transmission gear may not be pretty, but if incased as it should be it is comparatively noiseless, highly efficient, long-lived, and simple to repair.

\* \* \*

The real greatness of a man's business success becomes manifest only when he has made his success in a competitive business.

## DISAPPOINTING RESULTS OF ALTRUISM

By J. CROW TAYLOR\*

Ever since the writers of history have kept a record of things, we have found from time to time instances where fine theories and altruistic ideas that should have borne the best fruit in the world have proved disappointing. We often find cases where it seems that theory and practice do not get hitched up together right to do good work. Whether it is because they are misapplied or because of some unfortunate blunder or misconception of circumstances, it is impossible to say, but the fact remains just the same that we do come across these occasions of good theories going wrong.

There are at hand now two instances in point; one of these is in the discontinuing of a profit-sharing plan undertaken by Sir Christopher Furness, of England, who, in 1908, took his employes, numbering 3000, into a co-partnership with him in a shipbuilding business. This case was one of the most conspicuous on record of modern efforts at profit-sharing. It was heralded all around the world, and it has been watched with a great deal of interest. A report from Consul-General John L. Griffiths, of London, says that in December, 1909, the employes received a dividend of 9 per cent in addition to their wages, but were dissatisfied with the arrangement, and by a majority vote have decided to discontinue it. In this case, strange as it may seem, the report states that the objection to the profit-sharing plan came largely from the trade unions, and after nearly two years' trial it has been discontinued and other plans put into operation to prevent friction and disputes between employer and employee, or rather to prevent any disastrous results from differences of opinion. There has been organized a sort of works council, which will handle all questions of wages and other matters that might come up and cause dissension; but it seems that the profit-sharing plan has gone and in its place the workers will receive specific wages, and whether they buy shares of stock and take a part in the dividends of that company or any other company will be a matter of individual preference and action.

The other instance containing a note of disappointment comes in a report from Consul Augustus E. Ingram, of Bradford, England, concerning the annual report of the chief inspectors of factory and work shops of the United Kingdom. It may be recalled in this connection that back in 1906 there was put into operation in England a workmen's compensation act to compel the carrying of insurance for industrial accidents and a proper compensation of all employes injured by accidents while at work. The report of accidents for the calendar year of 1909 shows a total of 116,554 accidents (946 of which were fatal); in 1904 the number of accidents was only 91,954 (1018 fatal).

This report, Consul Ingram says, confirms a statement made by him in previous reports, that the number of industrial accidents had materially increased since the workmen's compensation act of 1906 has been in operation throughout the United Kingdom.

Therefore, we have had another case of disappointing results from putting into practice a fine theory based on altruistic ideas. It is probable, however, in this instance, that the disappointment is not as real as it seems, or rather that we are disappointed because too much was expected. The natural inference to be drawn from these figures is that the enforced compensation and the knowledge that compensation would be forthcoming has made workmen careless and reckless of accidents. Probably it has, too, in some instances, but it is difficult to conceive of a right-thinking man purposely endangering himself, even though he may know he will be compensated in case of injury. It is likely that we will be nearer right in this instance to assume that there really were no more accidents happening, but there were more *reported*, because of the fact that the compensation would make it worth while to report them, whereas previous to this there was no occasion to report trivial accidents or accidents wherein the one injured had no hopes of compensation or nothing to gain by making the report.

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## THE DESIGN OF GROUPED HELICAL SPRINGS\*

By EGBERT R. MORRISON†

It is the intention to present here, a study of the design of grouped helical springs, developing the subject upon the basis of the relation which exists between the diameter of the bar and the mean diameter of the spring. In the discussion only round bar coils will be considered.

### Notation

The following notation will be adopted:

$S$  = stress solid, or maximum stress, usually assumed to be 80,000 pounds per square inch for heavy steel springs;

$G$  = modulus of torsional elasticity, taken as 12,600,000 pounds per square inch for steel springs;

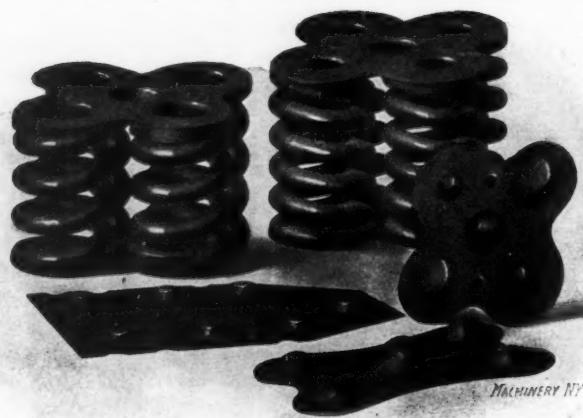


Fig. 1. Groups of Coil Springs held together by Plates at Top and Bottom

$w$  = weight of one cubic inch of the spring material;

$\pi = 3.1416$ ;

$f$  = total deflection;

$H$  = free height;

$h$  = solid height;

$h_1$  = any other height;

$P$  = capacity at solid height, or weight necessary to produce complete deflection;

$P_1$  = load at  $h_1$ , or weight necessary to compress to  $h_1$ ;

$W$  = weight of spring;

$L$  = blunt length of bar, or length before tapering;

$D$  = mean diameter of coil;

$d$  = diameter of round bar;

$r$  = spring index, or  $D \div d$ .

### Definitions

In addition to the above notation, the following definitions will serve to clear the discussion:

*Spring*: any single coil, combination, or group of coils.

*Coil*: a spring composed of one bar only.

*Turn*: a wind or rotation, a part of a coil.

*Turns* are fundamental elements; *coils* are composed of winds; and *springs* consist of one or more coils.

### The Spring Index

The *deflection* of a helical spring may be expressed as

$$f = \frac{\pi S}{G} \left( \frac{D}{d} \right)^2 h \quad (1)$$

The *capacity* may be expressed by

$$P = \frac{\pi S}{8} \left( \frac{d}{D} \right) d^2 \quad (2)$$

The *weight* may be expressed as

$$W = \frac{\pi^2 w D^2 h}{4} \left( \frac{d}{D} \right) \quad (3)$$

The *length of bar* to form the spring may be expressed

$$L = \pi \left( \frac{D}{d} \right) h \quad (4)$$

\* For additional information relating to the design of coiled springs, see the following article published in *MACHINERY*, railway edition, "The Design of Heavy Helical Springs for Railroad Cars," January, 1910.

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These four standard equations being solved, the length of bar required to make the spring will be known, as well as the spring weight, capacity and deflection. A further inspection of these formulas will show that all properties depend upon the ratio between the diameter of the bar and the mean diameter of the spring. This all-important ratio may, therefore, be aptly called the *spring index*, expressed as

$$r = \frac{D}{d}$$

### Fundamental Principle of Grouped Springs

Equation (2) gives one value of  $\frac{d}{D}$ , while equation (3) affords another. Equating,

$$\frac{8 P}{\pi S d^2} = \frac{4 W}{\pi w D^2 h} \quad (5)$$

Whence

$$P = \frac{W S}{2 \pi w h} \left( \frac{d}{D} \right)^2 \quad (6)$$

This is the fundamental principle of grouped spring design and means that when a constant weight of material is uniformly stressed, the resultant capacity varies inversely as the square of the spring index, and that the actual number of coils or dimensions thereof is immaterial for a constant weight and spring index.

### To Ascertain the Value of the Spring Index

Having given the desired capacity, free height, solid height and material of a spring, it may further be assumed that the maximum fiber stress and modulus of elasticity are also known. If then, the spring index be ascertained, the ratio of mean diameter of coil to diameter of bar that must be maintained in order to produce the results desired, will thus be given.

The value of the spring index from equation (1) is,

$$r = \frac{D}{d} = \sqrt{\frac{f G}{\pi S h}} \quad (7)$$

which may readily be solved since  $f = H - h$ , the difference between two known quantities.

### Constant Areas, the Basis of Bar Sizes and Dimensions

No matter of how many bars or coils the spring unit may be composed, the sum of the cross-sectional areas of the in-



Fig. 2. Double and Triple Coil Concentric Springs

dividual bars is constant. This fact furnishes a basis from which to ascertain the sizes and dimensions of the bars, according to whether there is one or more coils used. It is important, therefore, to deduce an expression for this constant area. Consider a single coil spring.

The product of equations (1) and (2) is

$$P f = \frac{\pi^2 S^2 d D h}{8 G}$$

which may be expressed

$$P f = \frac{S^2}{2 G} \left( \frac{\pi^2 d D h}{4} \right) \quad (8)$$

Then

$$\frac{\pi^2 d D h}{4} = \frac{2 G P f}{S^2} \quad (9)$$

Equation (3) may now be written

$$W = \left( \frac{\pi^2 d D h}{4} \right) w \quad (10)$$

Substituting the value of  $\frac{\pi^2 d D h}{4}$  as given in equation (9)

$$W = \frac{2 G P f w}{S^2} \quad (11)$$

The total weight divided by the unit weight will give the volume, or

$$V = \frac{W}{w} = \frac{2 G P f}{S^2}$$

From equation (4) the length of the bar will always be

$$L = \pi r h \quad (12)$$

The volume, divided by this constant length, will therefore result in an expression of the constant area, or

$$\frac{V}{L} = A = \frac{2 G P f}{\pi S^2 r h} \quad (13)$$

Substituting from equation (1) the value of  $f$ , placing  $\frac{D}{d} = r$ , gives

$$A = \frac{2 P r}{S} \quad (14)$$

which is the constant area value sought, and being in known terms may be readily obtained.

This applies equally well for a multi-coil spring, for the weight is uniformly taken up by each of the units of the spring. Therefore the total cross-sectional area is constant.

#### Determinate Equations for Bar Sizes and Dimensions

In concentric coils, let all the properties of the inner coil be denoted by the subscript 1; of the next coil by the subscript 2; of the next coil by the subscript 3; and so forth. The total sectional area will then always be

$$\frac{\pi d_1^2}{4} + \frac{\pi d_2^2}{4} + \dots + \frac{\pi d_n^2}{4} = \frac{2 P r}{S} \quad (15)$$

which may be expressed

$$\frac{\pi}{4} (d_1^2 + d_2^2 + d_3^2 + \dots + d_n^2) = \frac{2 P r}{S} \quad (16)$$

It is possible also from the relation of the diameters of the coils to form as many equations as there are coils less one,

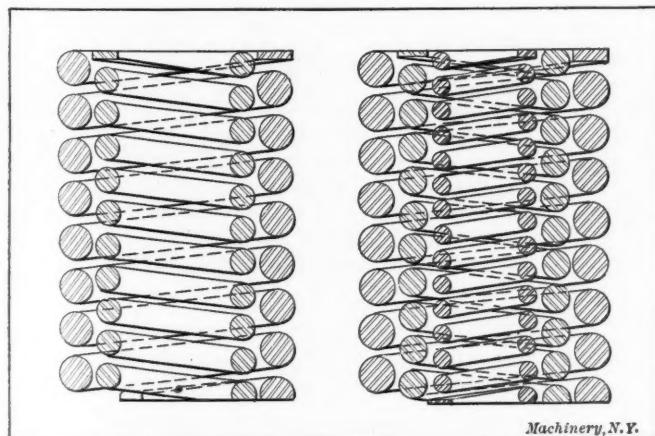


Fig. 3. Double and Triple Coil Concentric Groups, showing Right- and Left-hand Coiling, to prevent Binding.

so that there may be always found as many equations as there are unknown quantities, or bars, or values of  $d$ .

Equations based on the relations of coils are deduced as follows, where  $D_n'$  = inside diameter and  $D_n''$  = outside diameter of  $n$ th coil.

$$D_n'' = D_n' + d_n = d_n \left( \frac{D_n'}{d_n} \right) + d_n \quad (17)$$

or

$$D_n'' = (r + 1) d_n \quad (18)$$

In the same way

$$D_n' = (r - 1) d_n \quad (19)$$

Then let the difference between the outside diameter of one coil and the inside diameter of the next be taken as any desirable clearance,  $c$ . Or

$$D_n' - D_{n-1}'' = c \quad (20)$$

This gives the series of equations sought, thus:

Between first and second coils,

$$(r - 1) d_2 = (r + 1) d_1 + c \quad (21)$$

Between second and third coils,

$$(r - 1) d_3 = (r + 1) d_2 + c \quad (22)$$

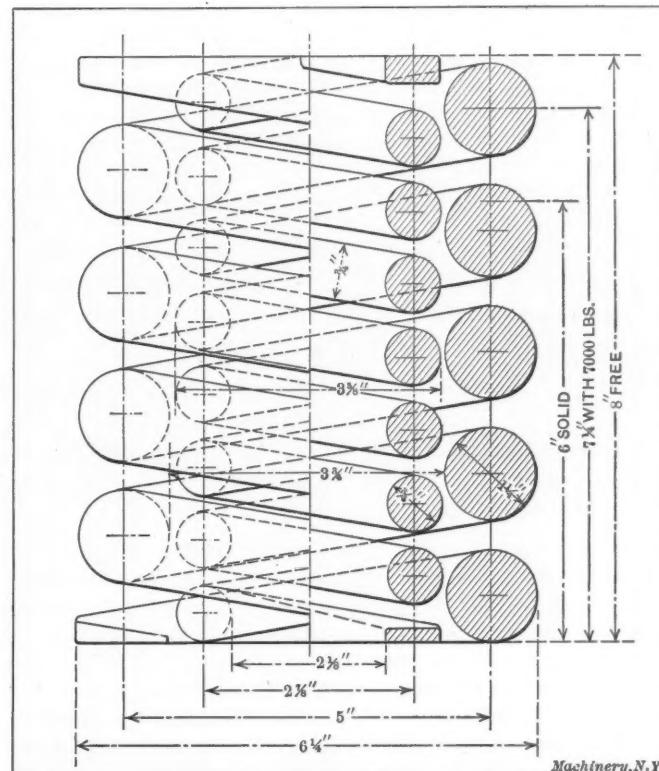


Fig. 4. A Concentric Group showing what is meant by "Solid", "Loaded" and "Free Heights". The Clearance between Coils is usually one-sixteenth inch.

Between third and fourth coils,

$$(r - 1) d_4 = (r + 1) d_3 + c \quad (23)$$

and so forth.

#### Equation of $d_1$ for Single Coil Spring

The value of  $d_1$ , or the diameter of the inner (in this case the only) bar may be obtained by writing equation (16) simply as:

$$\frac{\pi d_1^2}{4} = \frac{2 P}{S} r \quad (24)$$

which may be readily solved for  $d_1$  after making the proper numerical substitutions of the other quantities, thus:

$$d_1^2 = \frac{8 P}{\pi S} r \quad (25)$$

#### Equation of $d_1$ for Double Coil Spring

If there are reasons for desiring two coils in the spring, equation (21) gives

$$d_2 = \left( \frac{r + 1}{r - 1} \right) d_1 + \frac{c}{r - 1} \quad (26)$$

and from equation (16)

$$\frac{\pi}{4} (d_1^2 + d_2^2) = \frac{2 P}{S} r \quad (27)$$

Substituting the above value of  $d_2$  in this gives an equation which after substitution of constants may be readily solved for  $d_1$ , after which  $d_2$  and the outside diameters may be readily found. This substitution results in

$$d_1^2 + \left[ \left( \frac{r + 1}{r - 1} \right) d_1 + \frac{c}{r - 1} \right]^2 = \frac{8 P}{\pi S} (r) \quad (28)$$

Equation of  $d_1$  for Triple Coil Spring

If now three coils are desired, from equation (21) as before:

$$d_2 = \frac{r+1}{r-1} d_1 + \frac{c}{r-1} \quad (29)$$

and from equation (22)

$$d_3 = \frac{r+1}{r-1} d_2 + \frac{c}{r-1} \quad (30)$$

whence

$$d_3 = \left( \frac{r+1}{r-1} \right)^2 d_1 + \frac{r+1}{(r-1)^2} c + \frac{c}{r-1} \quad (31)$$

Then from equation (16)

$$\frac{\pi}{4} (d_1^2 + d_2^2 + d_3^2) = \frac{2P}{SG} r \quad (32)$$

whence

$$d_1^2 + \left( \frac{r+1}{r-1} d_1 + \frac{c}{r-1} \right)^2 + \left( \frac{(r+1)^2}{(r-1)^2} d_1 + \frac{r+1}{(r-1)^2} c + \frac{c}{r-1} \right)^2 = \frac{8P}{\pi S} r \quad (33)$$

Equation of  $d_1$  for any Number of Coils

From equation (14) it is apparent that if there be  $n$  number of coils, the  $n$ th value of  $d$ , or  $d_n$ , is always

$$d_n = \frac{r+1}{r-1} d_{n-1} + \frac{c}{r-1} \quad (34)$$

The general formula for  $d_1$  may therefore always be written, although every additional coil adds greatly to the complexity of the final expression.

## Obstacles in the Design of Concentric Coils

The increasing complexity of the equation of  $d_1$  offers an obstacle to the solution of the multi-coiled springs on strictly mathematical lines. A still greater obstacle in the use of the formulas deduced lies in the fact that commercially it is found economically practical to use only such sizes of bars as are commonly rolled by the mills. In the absence of tables giving the properties of various spring coils from which a selection may be readily made, it is believed that the above formulas, (25), (28), (33) and other similar formulas which may be readily deduced, will serve as guides to the best commercial sizes to use, which sizes being once determined may then be investigated and their future combined action ascertained with certainty. To make the manner of proceeding clearer, assume a definite problem.

## Solution of Problem by Foregoing Formulas

**Problem:** To ascertain the proper coils to use to support 35,464 pounds at 5.022 inches solid height, the free height to be 6.625 inches.

From equation (7) the spring index is

$$r = \sqrt{\frac{(6.625 - 5.022) 12,600,000}{3.1416 \times 80,000 \times 5.022}}$$

whence  $r = 4$ , closely.

**Size of Bar for One Coil Spring:**

By equation (25)

$$d_1^2 = \frac{8 \times 35464 \times 4}{3.1416 \times 80,000}$$

whence  $d_1 = 2\frac{1}{8}$  inches.

Therefore  $D = 4d_1 = 8\frac{1}{2}$  inches

and  $D'' = 5d_1 = 10\frac{5}{8}$  inches.

**Size of Bar for Two Coil Springs:**

Assume the usual clearance of  $1/16$  inch between coils, whence  $c = \frac{1}{16}$  inch. From equation (28)

$$d_1^2 + \left( \frac{5}{3} d_1 + \frac{1}{24} \right)^2 = \frac{8 \times 35464 \times 4}{3.1416 \times 80,000}$$

or

$$\frac{34}{9} d_1^2 + \frac{10}{72} d_1 + \frac{1}{576} = 4.5156$$

whence  $d_1 = 1.07$  inch and  $d_2 = 1.825$  inch. Therefore  $D_1'' = 3.35$  inches, and  $D_2'' = 9.125$  inches.

## Result of Adopting Bars of Commercial Sizes

The closest commercial sizes to suit the solution would then be

$d_1 = 1\frac{1}{16}$  inch, and  $d_2 = 1\frac{1}{8}$  inch, and  
 $D_1'' = 5\frac{5}{8}$  inches and  $D_2'' = 9\frac{1}{2}$  inches

The actual value of  $c$  is then

$$D_2' - D_1'' = 5\frac{1}{2} - 5\frac{5}{8} = \frac{1}{8}$$

Now turn the investigation to the two coils which have been selected. The spring index of the inner coil will be

$$r_1 = \frac{D_1}{d_1} = \frac{4\frac{5}{8}}{1\frac{1}{16}} = \frac{69}{17} = 4\frac{1}{17}$$

Of the outer coil,

$$r_2 = \frac{D_2}{d_2} = \frac{7\frac{5}{8}}{1\frac{1}{8}} = \frac{117}{29} = 4\frac{1}{29}$$

It may now be seen that although the design was based on a constant spring index, the limitations of practice and economy have rendered it impossible to maintain this ideal condition. As the spring indexes of the inner and outer coils are of different values, it is known at once that the deflections and lengths of bar will not be identical for the same solid height. This means that commencing with the same free height and compressing to the same height will cause one coil (that having the least value of spring index) to be stressed higher than the other.

If the value of the spring index has been diminished only slightly from that assumed, it is a safe assumption that the fiber stress will be increased but slightly beyond that assumed, in which case it is not necessary to calculate the actual stresses, but the real capacities may be arrived at directly by basing the calculations upon the modulus of elasticity. It is more satisfactory, however, to ascertain the fiber stresses also, and where the value of the spring index has been considerably altered such a course is imperative in order to keep within safe limits of stress.

## Solution of Actual Problem—Stresses

The results will be the same whether similar free heights be taken and compressed to the same maximum fiber stress, or whether a beginning be made with the same solid height extending to the same maximum stress; the maintenance of a uniform final stress results in final heights which are not uniform. Instead of different final heights the usual practice is to use uniform free and solid heights, with the result that each coil is then stressed differently as pointed out before.

In this case the actual stress in each coil is found by the formula

$$S = \frac{Gf}{\pi h} \left( \frac{d}{D} \right)^2$$

which is simply an expression of the fact that where the material used, and the free and solid heights are uniform, the stress varies inversely as the square of the spring index.

In the particular problem at hand, the stress in the inner coil would then be

$$S_1 = 4,010,695 \frac{6.625 - 5.022}{5.022} \left( \frac{17}{69} \right)^2 = 77,700 \text{ pounds}$$

and in the outer

$$S_2 = 4,010,695 \frac{6.625 - 5.022}{5.022} \left( \frac{29}{117} \right)^2 = 78,600 \text{ pounds}$$

Or, since

$$S_1 : S_2 :: \left( \frac{1}{r_1} \right)^2 : \left( \frac{1}{r_2} \right)^2$$

then

$$S_2 = \left( \frac{r_1}{r_2} \right)^2 S_1$$

or

$$S_2 = \left( \frac{29}{117} \right)^2 \left( \frac{69}{17} \right)^2 77,700 = 78,600 \text{ pounds}$$

which is the same as before.

The stresses being known, the load on each coil may now be solved by the following formula:

$$P = \frac{\pi S d^3}{8 D}$$

## Solution of Actual Problem—Capacities

Where the deviation from the assumed index is slight, the variation in the maximum stress will be correspondingly small, and the experienced designer is therefore safe in proceeding to estimate the capacity of his spring directly from dimensions and without reference to actual stresses. In this case use the formula

$$P = \frac{G f d^5}{8 h D^3}$$

TABLE I. COMPARISON BETWEEN ESTIMATED AND ACTUAL COIL SPRING RESULTS

	Estimated	Actual
Free height	6.625	6.625
Solid height } Assumed same	5.022	5.022
Deflection } as actual	1.603	1.603
Stress, inner coil	80,000	77,700
Stress, outer coil	80,000	78,600
Capacity	35,464	33,640
Diameter inner bar	1.07	1.0625
Diameter outer bar	1.825	1.8125
Outside diameter inner coil	5.35	5.375
Outside diameter outer coil	9.125	9.125

or, where  $G$  is 12,600,000 for steel springs

$$P = 1,575,000 \frac{f d^5}{h D^3}$$

This would give for the inner coil

$$P_1 = 1,575,000 \frac{6.625 - 5.022}{5.022} \frac{(1.0625)^5}{(4.8125)^3} = 8490$$

and for the outer,

$$P_2 = 1,575,000 \frac{6.625 - 5.022}{5.022} \frac{(1.8125)^5}{(7.3125)^3} = 25150$$

The capacity of the two coils together will then be

$$P_1 + P_2 = P = 33,640 \text{ pounds}$$

Some idea of the difference which exists in the theoretical

centric groups, may be held together between spring plates of malleable cast iron or pressed steel. Such groups naturally offer greater stability than concentric groups; but, where the concentric group affords sufficient capacity and stability it should be used, as it is more economical of space and does not necessitate the use of spring plates to hold the different coils together. As the load should be supported firmly upon the center of the unit, the group should be arranged with such symmetry that the supporting forces, or spring resistances, will balance about any axis.

The designing of groups of this kind consists in the simple operation of dividing the load into as many parts as there will be units in the group. Then, maintaining the desired free heights and solid heights, and hence the same constant spring index, proceed to design the separate unit in the manner just presented for the simple concentric. Ordinarily much time and labor may be saved by remembering that halving the diameters of bar and coil reduces the capacity and weight to one-quarter, but does not affect length of bar or deflection of coil. This is due to the fact that this really halves the spring index with effect as indicated in formulas (1), (2), (3) and (4).

As illustrating clearly the comparison between different but equivalent springs, Table II is included in this article, showing four equivalent arrangements. The reader will note that as more coils are used a more compact design becomes possible for the concentric arrangements. The size of the bars reduces also, which makes possible better tempering.

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## FLOW OF METALS UNDER COMPRESSION

It was demonstrated several years ago at McGill University that bronze chips could be welded together cold by heavy pressure. The experiment showed that the bronze flowed under pressure like water and that the molecules of adjacent pieces coalesced the same as lead when subjected to a much less pressure. This interesting fact has an unpleasant side, as several machine-tool builders have discovered. It had become a common practice to bush working parts with a certain bronze, these bushings being forced into the holes with considerable pressure. When the bearing parts were immediately put to use, little or no trouble was experienced, but when laid

TABLE II. COMPARISON OF FOUR COIL SPRING GROUPS FOR SAME CAPACITY

	Description		O. D. or Equivalent, Ins.	Free, Ins.	Solid, Ins.	Bars, Ins.	Spring Index	Capacity, Pounds	Weight per Inch Solid Height, Pounds	Length of Bar per Inch Height, Ins.
Group A	Four similar coils in spring plates		11 to 12	6 $\frac{1}{2}$ between plates	5.09 betw'n plates	1 $\frac{1}{8}$	4	4 $\times$ 8866 = 35,464	4 $\times$ 3.1569 = 12.63	12.57
Group B	Single coil		10 $\frac{1}{2}$	6 $\frac{1}{2}$	5.09	2 $\frac{1}{8}$	4	35,464	12.63	12.57
Group C	Double coil, concentric	Outer	9 $\frac{1}{2}$	6 $\frac{1}{2}$	5.09	1 $\frac{1}{8}$	4	37,611	9.83	12.57
		Inner	5	6 $\frac{1}{2}$	5.09	1	4	7,853	2.80	12.57
Group D	Triple coil, concentric	Outer	8 $\frac{1}{2}$	6 $\frac{1}{2}$	5.09	1 $\frac{1}{8}$	4	24,076	8.56	12.57
		Medium	5	6 $\frac{1}{2}$	5.09	1	4	7,854	2.80	12.57
		Inner	2 $\frac{1}{8}$	6 $\frac{1}{2}$	5.09	$\frac{9}{16}$	4	2,485	0.88	12.57
								34,415	12.24	

and practical design may now be gained from Table I, which makes a detailed comparison.

## Limitations of Concentric Grouping

It is now apparent that in a spring concentrically arranged the inner bars are properly the smaller, and the greatest load is naturally upon the outer. There is a point, however, beyond which more inner coils will cease to be of advantage owing to the small gain in capacity. The addition of outer coils is also soon limited by the impossibility of coiling and tempering large bars. It is therefore evident that the load which may be carried by the concentric group is limited.

## Spring Plate Groups

Where greater capacity is desirable than can be obtained by concentric grouping, several single coils, or several con-

centric groups, may be held together between spring plates of malleable cast iron or pressed steel. Such groups naturally offer greater stability than concentric groups; but, where the concentric group affords sufficient capacity and stability it should be used, as it is more economical of space and does not necessitate the use of spring plates to hold the different coils together. As the load should be supported firmly upon the center of the unit, the group should be arranged with such symmetry that the supporting forces, or spring resistances, will balance about any axis.

\* \* \*

An expert on the valuation of automobile factory equipment charges off 10 per cent annually for depreciation of standard machine tools, 35 to 50 per cent for depreciation of jigs and fixtures, and 100 per cent for depreciation of reamers, counterbores, drills, etc.

## STRENGTH OF STEEL CASTINGS\*

By E. F. LAKE†

Along with the general advance that has taken place in the chemical composition and physical properties of all metals, steel castings have shown a decided improvement in the past decade or two. Some of these improvements have been due to new ingredients that have been added to steel to make the numerous alloys now on the market; others are due to a better knowledge of the chemical composition of steel; of how to remove the impurities; of how to melt, mix and pour the metal, and how to make, vent and gate the molds into which the metal is poured to form the castings. This knowledge has enabled the steel foundries to greatly improve the ordinary carbon steel castings. Their tensile strength, elastic limit,

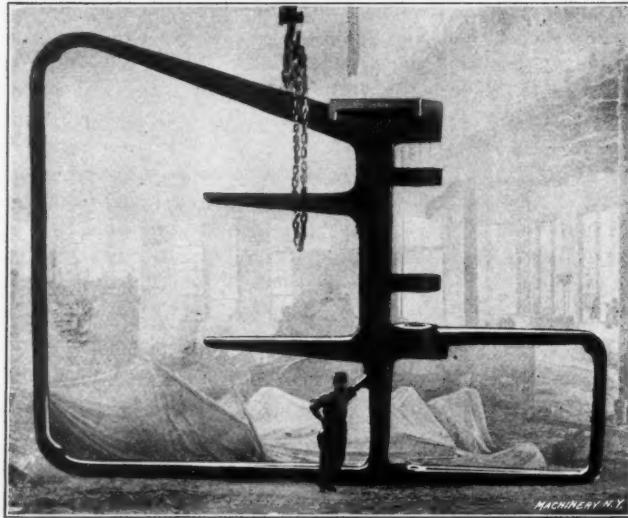


Fig. 1. Steel Casting for the Rudder Frame of a Large Naval Vessel

etc., have been increased something like 50 per cent over that of twenty-five years ago; and their resistance to hydraulic pressure and impact has been increased even more than this. As they are many times stronger than wrought, cast or malleable iron, and have an extreme toughness, they are very use-

## Strength Required in Steel Castings

The increase in strength is well illustrated by a comparative study of the early editions of Wm. Kent's handbook, which gave the tensile strength of steel castings as 40,000 pounds per square inch and the elastic limit as 20,000 pounds. This was the greatest strength that could be guaranteed by the

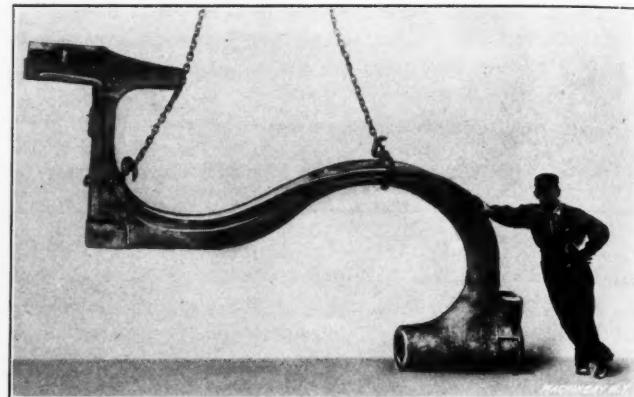


Fig. 2. Stern-post of a Torpedo Boat Destroyer made of Cast Steel

foundries at that time for the ordinary soft or low-carbon steel castings. To-day, however, there is hardly a steel foundry in the country but what will guarantee a tensile strength of 60,000 pounds and an elastic limit of 30,000 pounds for soft steel castings. In the case of the high-carbon steel castings these figures are exceeded by from 25 to 50 per cent.

## Steel Castings for U. S. Army and Navy

The ordnance department of the United States army and navy demand steel castings with a tensile strength varying from not less than 60,000 to 85,000 pounds per square inch; an elastic limit of from 25,000 to 45,000 pounds per square inch; an elongation in 2 inches of from 25 to 12 per cent; and a reduction in area from 30 to 18 per cent, according to the service to which they are to be subjected. For moving parts of machinery, a tensile strength of at least 70,000 pounds, with an elongation of at least 20 per cent in 2 inches is demanded. Test bars  $\frac{1}{2}$  by 1 inch must be capable of being

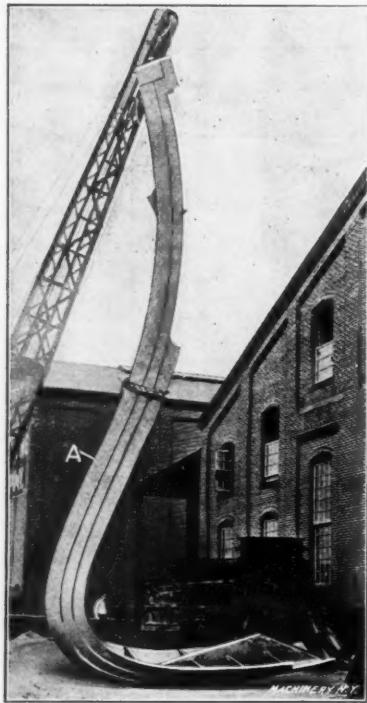


Fig. 3. Steel Casting for the Bow of a Man-of-war



Fig. 4. Locomotive Side Frame Bent Cold without Fracture

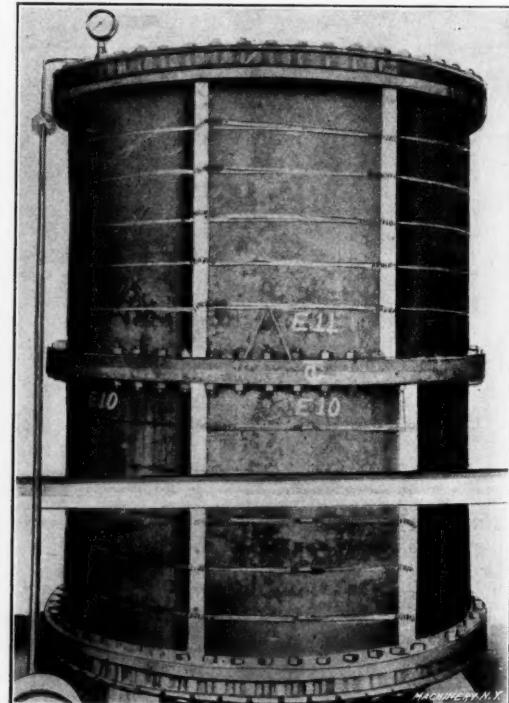


Fig. 5. Complete Hydraulic Cylinder made in Two Parts and Tested at a Pressure of 1800 Pounds per Square Inch

ful for machine parts that must carry heavy loads and withstand thrusts or other jolts and shocks incident to hard service.

\* See MACHINERY, June, 1903, engineering edition, "Steel Castings." See also MACHINERY's Reference Series No. 36, "Iron and Steel," second edition, Chapter III.

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bent cold 180 degrees, without fracture, around a radius that is not greater than 1 inch.

Some of the largest steel castings that have been made to meet these requirements are shown in Figs. 1, 2 and 3. These, as well as the other castings illustrated in this article, were made by the Penn Steel Casting & Machine Co. of Chester,

Pa. They were used on different vessels that have been built for the U. S. navy. In comparison with other metals, the greater strength and toughness of steel permits of a material reduction in the section for a given strength. Thus a corresponding decrease in weight is obtained, and for this reason steel castings have displaced all others in the construction of the war vessels of the navy. The merchant marines have also adopted them in places where great power or special strength has been required.

In Fig. 1 is shown the cast-steel rudder frame of one of the largest vessels in the navy. It is about 22 feet high and 28 feet long, over-all, and its weight is something like 40,000

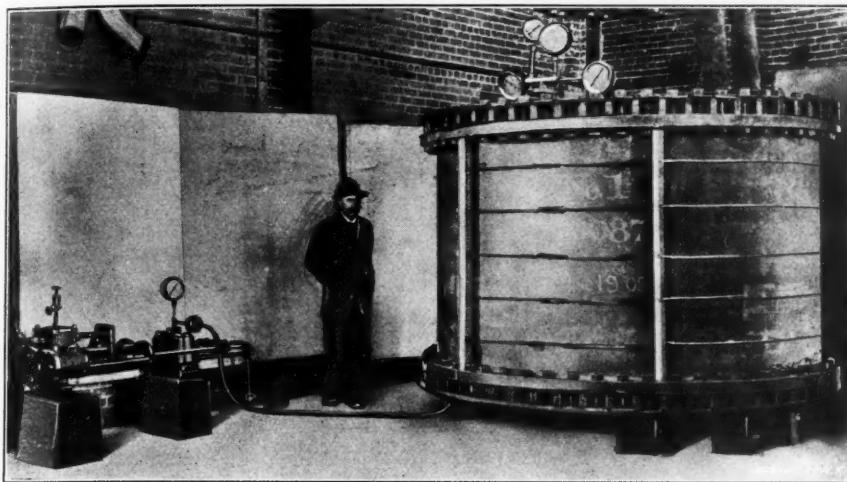


Fig. 6. Testing the Hydraulic Cylinders for the Locks at Peterboro, Ontario

pounds. The comparatively small section for a casting so large, over-all, makes it a difficult one to mold and retain the required strength in the metal. As the total shrinkage in its height and length would be from 2 to 3 inches, the mold must be rammed loose enough so that the metal will crush it when cooling. If this did not occur, the metal would either stretch and thus become weakened, or would crack. As soon as the metal solidifies, the cope must be removed and the casting uncovered to further aid the shrinkage.

If castings of this size can be made to the specifications just given there can be no good reason for not being able to make ordinary machine parts that would excel them. In smaller castings, blow-holes, porous or spongy metal, etc., are more easily kept out of the casting, and it is possible to get

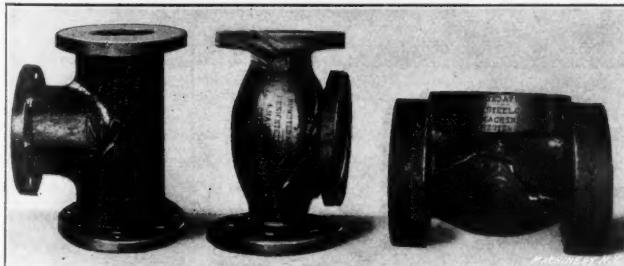


Fig. 7. Tee and Globe Valves Tested to Destruction

a denser and finer grained metal. Therefore, greater strength could be obtained.

In Fig. 3 is shown the casting that fits over the extreme front end or bow of a naval vessel. The edge at A is quite sharp for cleaving the water and minimizing the resistance to speed. The bulge of the bow is for the purpose of ramming other vessels. In Fig. 2 is shown the stern post of a torpedo boat destroyer.

#### Locomotive Side Frames

Many locomotive side frames are cast, and these are usually made of ordinary carbon steel containing about 0.30 per cent carbon. Some railroads, however, use vanadium steel side frames. The side frame shown in Fig. 4 was made of 30 point carbon steel, and in the molding it developed an indentation at B that was probably caused by gas or air being trapped in the mold in the form of a bubble. This gave the inspector for the railroad an idea that blow-holes were pres-

ent, and he condemned the casting. In order to prove to the inspector that the casting was good, the foundryman placed it under the drop hammer and bent it as shown, with several blows. The casting in this shape showed no indications of cracking, or even checking, at the bend. This shows the toughness obtainable in ordinary carbon-steel castings.

#### Hydraulic Cylinders

When the hydraulic-lift lock was built at Peterboro, Ont., a large number of steel castings were used, and the Penn Steel Casting & Machine Co. furnished the entire hydraulic outfit. One pair of the cylinder castings is shown in Fig. 5, as arranged for testing. The two castings form a complete cylinder and were tested with 1800 pounds hydraulic pressure per square inch after the castings had been annealed. In Fig. 6 is shown a single casting with covers clamped on the top and bottom, and the apparatus that was used for making the tests. To the left in the half-tone will be seen the pump, while on top of the casting the gages are arranged. The five bands shown around the casting were placed there to show any enlargement of the casting that might take place from the pressure exerted on the inside.

The first casting that was tested was not annealed. Owing to its large size it was thought best to save this expense, if possible. When it was subjected to 1200 pounds hydraulic pressure per square inch, however, the circumferential bands showed that it had sprung 1 1/4 inch, and it was not considered safe to raise the pressure any higher. When the pressure was released the bands recorded a permanent set of 1/4 inch. After this the castings were annealed, and when twenty others were tested to 1800

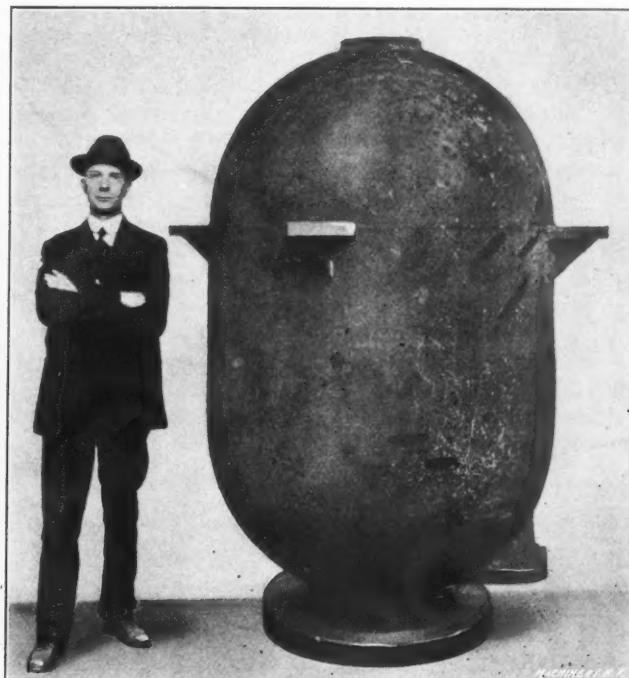


Fig. 8. Cast-steel Retorts Tested with a Pressure of 600 Pounds per Square Inch

pounds pressure, no permanent set was indicated. On the first one it was thought that the elastic limit had been exceeded, but this proved not to be the case. The chemical analysis of the metal used in the castings was as follows:

Carbon	0.24	per cent,
Silicon	0.31	per cent,
Manganese	0.60	per cent,
Sulphur	0.037	per cent,
Phosphorus	0.038	per cent.

#### Destructive Tests on Steel Castings

Some smaller castings made from the same metal were tested to the bursting point. These are shown in Fig. 7. The

one to the left is an 8-inch tee, with walls  $\frac{3}{4}$  inch thick, such as is used for the high-pressure fire main system in Philadelphia. This tee did not burst until the hydraulic pressure reached 6800 pounds per square inch. The other two castings are 2 1/2-inch globe valve bodies, with walls 7/16 inch thick. The one in the center stood a pressure of 9500 pounds per

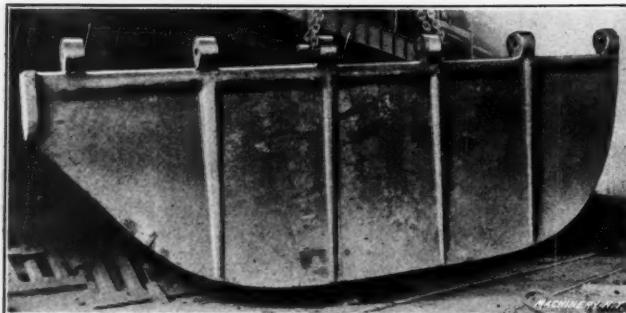


Fig. 9. A Cast-steel Rudder about 27 1/2 Feet Long and Weighing 45,000 Pounds

square inch before it burst, and the one to the right withstood 9900 pounds.

The cast-steel retorts shown in Fig. 8 are all tested with a pressure of 600 pounds per square inch before they leave the foundry. This hydraulic test not only proves that the steel castings made to-day have the necessary strength, but also that they are free from blow-holes, porous or spongy spots, etc., because the water would certainly find its way through

#### RESULTS OF TESTS ON STEEL CASTINGS

Kind of Steel	Heat Number	Mark Number	Pounds per Square Inch		Percentage of	
			Elastic Limit	Tensile Strength	Elongation	Reduction of Area
Soft	8451	1	33,000	67,600	31.0	40.9
	8451	2	34,400	64,600	29.0	39.4
	8451	3	31,600	69,200	31.5	41.9
	8451	4	34,400	68,400	34.0	42.4
	8451	5	35,200	67,600	33.0	41.9
	8451	6	35,200	68,000	29.5	36.3
	8451	7	35,600	67,600	32.0	42.7
	8451	8	33,800	64,400	31.0	39.0
	8480	1	34,000	67,600	28.0	39.7
	8480	3	34,400	69,000	30.0	38.4
	8480	5	33,600	67,000	31.5	41.7
	8410	1	36,000	73,500	28.0	37.2
Medium	8410	2	36,500	74,000	27.0	36.0
	8436	1	36,000	72,500	26.0	40.3
	8436	2	36,500	75,000	27.0	42.5
	8464	1	36,000	70,500	32.0	47.8
	8464	2	35,500	71,000	30.0	44.9
	8464	3	36,000	72,500	27.0	37.2
	8464	4	35,500	71,500	29.5	46.3
	8464	5	36,000	72,000	32.0	46.3
	8464	6	36,000	72,500	27.0	35.7
	8473	1	36,000	72,500	27.5	37.2
	8473	2	37,000	73,000	26.0	40.3
	8476	2	45,000	85,000	17.5	24.1
Hard	8476	3	45,500	85,000	18.0	21.0
	8476	4	45,500	85,500	19.0	24.1
	8476	5	45,000	85,000	18.0	21.3
	8476	6	45,000	85,000	22.0	24.1
	8476	7	45,500	85,000	18.5	22.0
	8476	8	45,000	88,000	17.5	22.0
	8476	10	45,500	87,000	15.0	20.6
	8476	11	45,500	87,000	17.0	20.6
	8476	12	46,000	86,000	17.0	20.6
	8485	1	45,800	85,200	19.0	22.4
	8485	2	45,500	85,000	21.0	32.7

the metal in the castings at much lower pressures than those given above, if there were any weak spots in them.

The rudder shown in Fig. 9 is one of the largest steel castings made. It is about 27 feet long and weighs about 45,000 pounds. The casting shown in the two views Figs. 10 and 11 weighs 98,000 pounds.

#### Results of Tests

The uniformity with which steel castings can be made to the government specifications is shown in the accompanying

table. The tests were made by the Ordnance Bureau of the U. S. Army and Navy, from test bars that were cast on the various castings.

The soft and medium steels bent 180 degrees around a 1-inch radius, and the hard steel 160 degrees, without showing any signs of fracture. When broken, all the test pieces showed a silky fracture. The test pieces were 0.505 inch in diameter with an area of 0.2 square inch.

The many other properties characteristic of steel castings made for special purposes, may be taken up at some future time. As an instance, may be mentioned the castings made for electrical purposes, which have a softness, homogeneity and soundness that insures a high and uniform permeability.

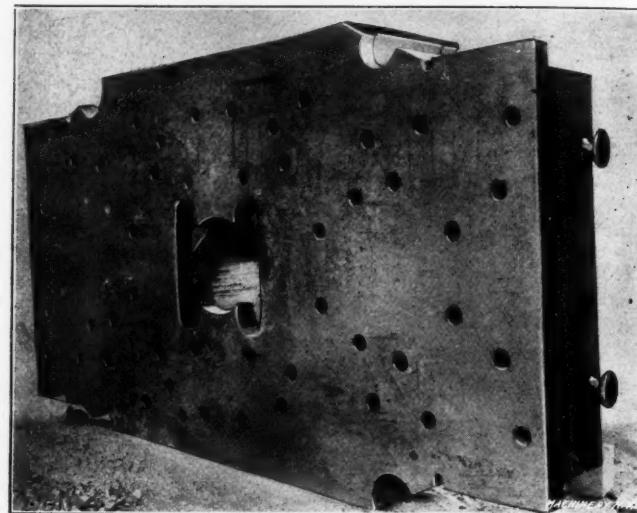


Fig. 10. A Steel Casting Weighing 98,000 Pounds

This metal shows magnetic saturation curves and a hysteresis curvature that is equal to the best so-called "Norway" iron.

Numerous metals that are more or less rare are also added to steel to make alloys with special properties. Where steel

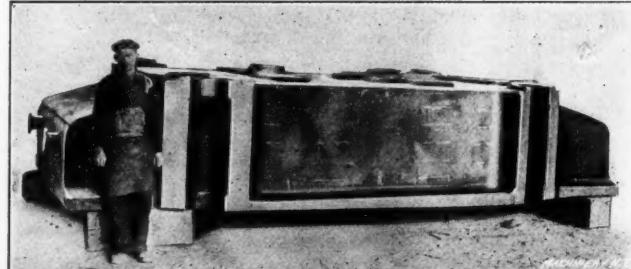


Fig. 11. Another View of the Steel Casting shown in Fig. 10. This is One of the Largest Steel Castings made

castings can be used, nearly any condition or requirement demanded of the part can be met with by the addition of these alloying materials, or by the careful work necessary to produce pure, sound and homogeneous metal, or by both.

\* \* \*

#### APPLYING SCIENTIFIC KNOWLEDGE

One of the common faults of some educated men is that they make little or no application of the scientific facts learned in school to the everyday problems of life. Perhaps it is because they are literal-minded, the principles having for them only the applications mentioned in the book. For instance, two young men, both graduates of the same high school, some years after graduation got into an argument on whether the weight of a block of wood floating in a pail of water is added to the weight of the pail and water or not. Experiment, of course, showed that it is, whereupon the one who was worsted quoted the Archimedean law to the effect that a floating body displaces its weight of the liquid, and was inclined to doubt the soundness of the old Greek's dictum after making the test. The fact that the mere displacement of a liquid does not alter its weight had never before been made plain to him, and not until a pail brimming over was tested did he grasp the full significance of the law.

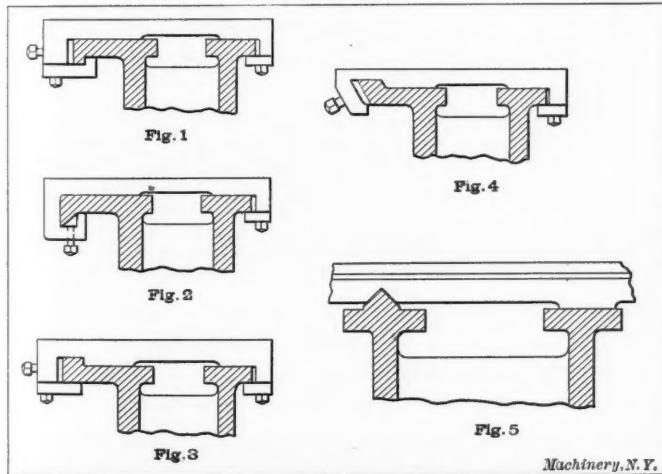
## LATHE BEDS AND DOUBLE BACK-GEARING— A COMMENT

By RACQUET

In the December number of *MACHINERY*, engineering edition, an English 24-inch lathe was illustrated and described. The general design of this machine seems excellent, but the writer wishes to comment on a few of the statements made

The "narrow" guide for the carriage is, in the writer's opinion, one of the best on the market. The lead-screw and the feed-rack are by this device brought quite close to the center of the guides, and the surface on which the straightness of the carriage motion along the bed depends, is so located that it is impossible for it to be bruised by a blow, or cut by the chips. It is stated in the article referred to that this feature is protected by patents, but it is difficult to see how this patent could be sustained. In the accompanying illustrations Figs. 1 to 5, are shown five designs of lathe beds, each of which is provided with some form of "narrow" guide. These designs are all taken from "Modern Machine Shop Practice" by Joshua Rose, a work which was published about 1887. This construction, therefore, it would seem, should be more generally known than it appears to be. The designs shown in Figs. 1 and 2 are practically identical with that described in the article referred to, although, of course, the new machine is provided with the modern taper adjusting gibbs. The designs shown in Figs. 3 and 4 are similar to a design brought out eight or ten years ago by the Scotch lathe manufacturers, Messrs. Lang. The design in Fig. 5 embodies the principle applied to the American or raised V-type of bed, which design, more or less modified, is becoming popular with American lathe designers. Hence, it is apparent that the narrow front guide is a comparatively old idea, although it is a very important one, and one which ought to be applied, particularly, to the flat or English type of lathe bed.

In an editorial foot-note accompanying the article mentioned, it is stated that the coarse-pitch screw-cutting arrangement was used many years ago on a Putnam lathe. In Rose's "Mod-

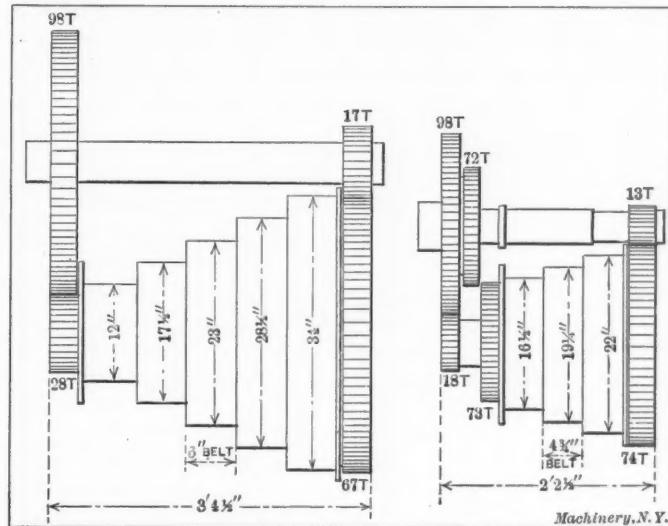


Figs. 1 to 5. Five Different Designs of "Narrow Guide" Lathe Beds

ern Machine Shop Practice," already referred to, a drawing of a headstock of a Putnam lathe is shown, having a coarse screw-cutting arrangement similar to that of the Ward, Haggas & Smith lathe, the only difference being that the Putnam lathe has a single sliding gear and no reverse gears; and as it had no double back-gears, only two pitches could be cut with each train of change gears, instead of three.

In speaking of double back-gears, attention is called to the possibility of removing more metal per hour by a double back-gear lathe than is possible with a lathe using a much larger cone and single back-gear. To emphasize this idea the writer would call attention to the accompanying illustrations Figs. 6 and 7. In Fig. 6 is shown the ordinary back-gear arrangement as it appears in a well-known make of 32-inch lathe. It will be seen that the driving cone is very large, the largest step in fact being two inches larger than the swing of the lathe, and the belt six inches wide. In Fig. 7 is shown a double back-gear lathe head arrangement, also for an exist-

ing 32-inch lathe, the cone diameters and gear ratios being slightly modified so that the two arrangements may be more easily compared. Now if we use the formula  $P = D \times W \times R$ , in which  $D$  = diameter of the cone step;  $W$  = the width of belt, and  $R$  = ratio of gearing, and find the value of  $P$  for each of the spindle speeds, and then take the average of these, we are in a position to compare the driving power of the two arrangements. Ordinarily, if one saw the two drives shown in Figs. 6 and 7 side by side, one would say that the drive shown in Fig. 6 is at least twice as powerful as that shown in Fig. 7. This conclusion is quite reasonable from a casual glance. If, however, the calculation indicated above is carried out, one would find that the small cone, instead of making



Figs. 6 and 7. A Comparison of Two Lathe Cone and Back-gear Designs

the lathe less powerful, actually is 12 per cent more powerful, due to the higher belt speed. The average horsepower transmitted by the belt is also greater, and there is no doubt whatever that a 4 3/4-inch belt is more easily manipulated than a 6-inch belt, while the shortening of the headstock by 14 inches is an item worthy of consideration.

The detailed information relating to the head shown in Fig. 6 is as follows: Gear ratio, 13.8 to 1; countershaft speeds, 212 and 166 R. P. M.; average belt and gear purchase, 1,020; average horsepower of belt, 17 1/4; range of spindle speeds, 4.25 to 600 R. P. M. For the head shown in Fig. 7 the data are: Gearing ratios, 5.6 to 1 and 31 to 1; countershaft speeds, 450 and 190 R. P. M.; average belt and gear purchase, 1,140; average horsepower of belt, 19 1/2; range of spindle speeds, 4.6 to 600 R. P. M.

In the writer's opinion the double back-gear head is but a step removed from the geared head or single pulley drive, and the simplicity of the double back-gear drive counteracts to a considerable extent the advantages of the single pulley drive which can be fully realized only by the introduction of a more or less complicated design.

\* \* \*

An interesting item relating to the cost of railway travel in Europe is published in the *Daily Consular and Trade Reports*, of December 8, issued by the Department of Commerce and Labor. In this, Consul-General John H. Snodgrass, of Moscow, states that "the actual cost of traveling in Russia is much less than in the United States, especially if one takes a second-class ticket, which is quite as satisfactory as first-class, provided the trains are not crowded. The actual second-class tariff is very little over 1 cent a mile." This is but another testimony to the fact that the cost of travel is less on the European continent than in America, the assertions of many persons to the contrary notwithstanding.

\* \* \*

The manufacturers of the Santos-Dumont monoplane have, according to a French contemporary, offered to supply this monoplane at the price of \$750 apiece if ten machines are ordered at a time. With prices for flying machines cut to such a figure, it appears that flying races might become as popular as automobile races, and nearly as dangerous.

## CALCULATION OF CIRCULAR FORMING TOOLS\*

By WILLIAM W. JOHNSON;

When a large number of circular forming tools are to be designed, it involves a great deal of labor to compute the different diameters separately. The usual method is as follows (see Fig. 1):

First find the value of  $W$  in the right-angle triangle  $BCD$ :

$$W = \sqrt{R^2 - h^2}$$

in which

$R$  = radius of largest diameter of circular tool,

$h$  = distance which the center of the tool is set, either above or below the center line of the work.

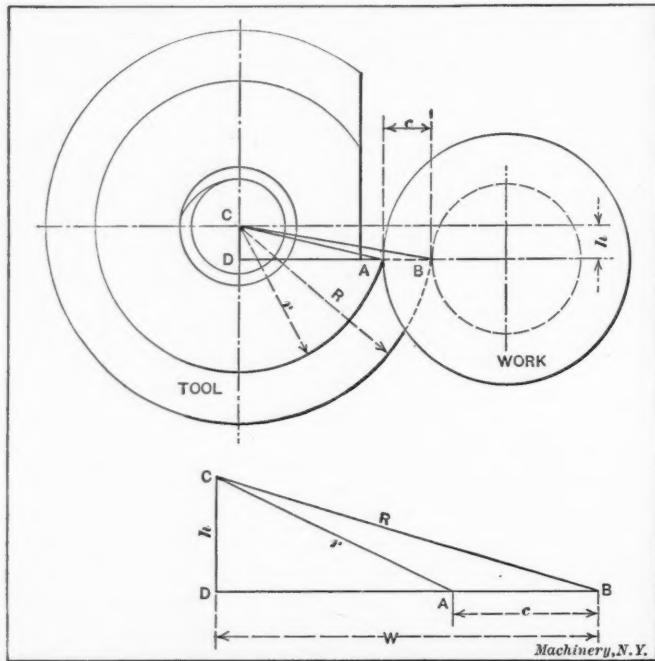


Fig. 1. Notation used in Formulas for Forming Tool Calculations

Now, find the value of  $r$  in the right-angle triangle  $ACD$ :

$$r = \sqrt{(W - c)^2 + h^2}$$

in which

$c$  = one-half the difference between the required diameters of the work,

$r$  = the required radius of the circular tool.

This method is quite long and cannot be materially shortened by using a table of squares. Therefore, anything that

TABLE I. DIMENSIONS FOR FORMING TOOLS FOR BROWN & SHARPE SCREW MACHINES

Number of Machine	D	h	Tap, Left-hand	W
00	1 1/4	1/8	15-16	1/4
0	2 1/4	5/8	14-15	5/8
2	3	1/4	12-13	5/8

can be done to aid in computing the different diameters of circular forming tools will no doubt be appreciated. The purpose of this article is to show how to compute tables giving the diameters of circular tools corresponding to differences of one-thousandth inch in the radius of the work. Such tables are given in the accompanying Data Sheet Supplement.

In Table I are given the dimensions required for designing circular forming tools for Brown & Sharpe automatic screw machines. (See Fig. 2 for notation used.) For the purpose of illustration, a table of diameters for circular forming tools for the No. 2 machine will be computed. The method can be applied universally, however, provided the tools have

\* With Data Sheet Supplement.

† For previous articles relating to circular forming tools, see MACHINERY, March and April, 1910, "Circular Form and Cut-off Tools"; January, 1908, "Formulas for Circular Forming Tools"; October, 1904, "Charts for Forming Tools"; June, 1904, "Straight and Circular Forming Tools."

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no top rake. The conditions of the problem are shown diagrammatically in Fig. 3. The notation is the same as that used in Fig. 1.

Let

$n$  = the numbers 1, 2, 3, 4, etc., successively,

$c = 0.001 n$ .

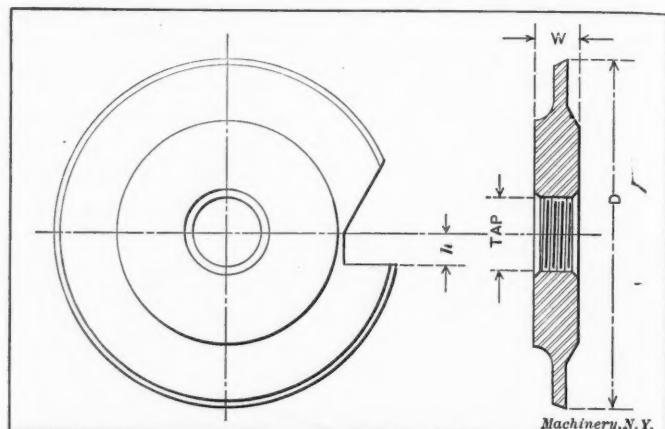


Fig. 2. Notation used in Table I

From Fig. 3 we have:

$$\sin CBD = \frac{h}{R}$$

From Table I we have  $h = 1/4$  and  $R = 1\frac{1}{2}$ , and hence:

$$\sin CBD = \frac{1}{6}$$

$$\cos CBD = \sqrt{1 - \sin^2 CBD} = \sqrt{\frac{35}{36}} = 0.9860133$$

From the "law of cosines" in trigonometry, we obtain:

$$r = \sqrt{R^2 + c^2 - 2 R c \times \cos CBD}$$

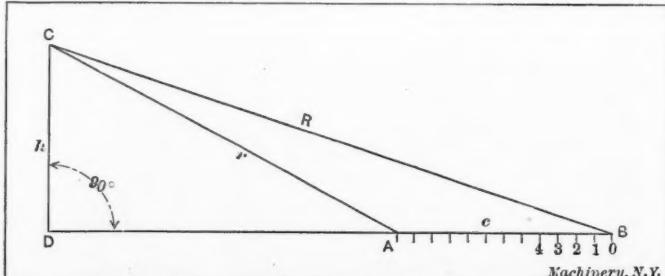


Fig. 3. Notation used in Formulas for Calculating Table II

Substituting the known values, we have:

$$r = \sqrt{2.25 + 0.000001 n^2 - 0.0029580399 n}$$

To shorten the numerical work we can now calculate  $r$  for  $n = 50$ ,  $n = 100$ ,  $n = 150$ , etc., which is equivalent to consid-

TABLE II. VALUES OF  $r$  FOR DIFFERENT VALUES OF  $n$

n	r	Difference between Radii for $n = 50$	Corresponding Difference for $n = 1$	2r	Double Difference ( $n = 1$ )
0	1.500000	0.049277	0.0009855	3.000000	0.001971
50	1.450723	0.049225	0.0009845	2.901446	0.001969
100	1.401498	0.049169	0.0009834	2.802996	0.001967
150	1.352329	0.049105	0.0009821	2.704658	0.001964
200	1.303224	0.049035	0.0009807	2.606448	0.001961
250	1.254189	0.048955	0.0009791	2.508278	0.001958
300	1.205234	0.048866	0.0009773	2.400468	0.001955
350	1.156368	0.048765	0.0009758	2.312736	0.001951
400	1.107603	0.048650	0.0009730	2.215206	0.001946
450	1.058953	0.048517	0.0009703	2.117906	0.001941
500	1.010436			2.020872	

ering the distance  $AB$ , Fig. 3, divided into a number of equal divisions, each 0.001 inch long, and computing the radius  $r$  for  $AB = 0.050$ ,  $AB = 0.100$ , etc. By trial it can be determined that the values of  $r$  for other values of  $n$  can be interpolated between those calculated, so that the interpolated values will be correct to four decimal places. Hence, by computing the

values of  $r$ , as stated, by the formula just given, we obtain the values in Table II. The fourth column in this table gives the differences of radii corresponding to a difference of 0.001 inch in the length of a line  $AB$ . By multiplying the values of  $r$  and the differences for 0.001 inch, by 2, we obtain the diameter and diametral differences directly, as shown in the last two columns. The tables in the Data Sheet Supplement are computed by simply subtracting these diametral differences, as given in Table II, from each preceding diameter, as indicated below.

For

$$n = 0, 2r = 3.000000$$

$$n = 1, 2r = 3.000000 - 0.001971 = 2.998029$$

$$n = 2, 2r = 2.998029 - 0.001971 = 2.996058$$

and so forth to  $n = 49$ .

For

$$n = 50, 2r = 2.901446 - 0.001969 = 2.899477$$

$$n = 51, 2r = 2.899477 - 0.001969 = 2.897508$$

$$n = 52, 2r = 2.897508 - 0.001969 = 2.895539$$

and so forth to  $n = 99$ . In this way the calculations are continued until the table is completed.

The following example will illustrate the practical application of the tables in the Data Sheet Supplement. Assume that we wish to design a circular forming tool to turn the piece shown in Fig. 4, on a No. 0 Brown & Sharpe automatic screw machine. Let the largest diameter of the circular tool

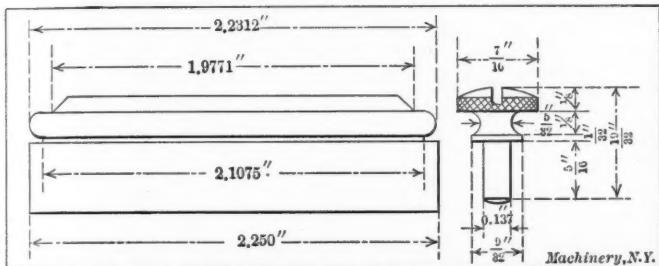


Fig. 4. Dimensions of Work and Tool in the Practical Example Given

correspond with the smallest diameter on the piece. Then find one-half the difference between the required diameters of the work as follows:

$$\frac{5}{32} - 0.137 = \frac{0.156 - 0.137}{2} = \frac{0.019}{2} = 0.0095 \text{ inch}$$

$$\frac{9}{32} - 0.137 = \frac{0.281 - 0.137}{2} = \frac{0.144}{2} = 0.072 \text{ inch}$$

$$\frac{\left(\frac{7}{16} - 0.024\right) - 0.137}{2} = \frac{0.276}{2} = 0.138 \text{ inch}$$

From the tables in the accompanying Supplement, we find opposite 0.0095,\* in the column headed No. 0 the value 2.2312, which is the diameter to which to turn the circular tool to produce the 5/32 inch diameter on the work when the largest diameter of the circular tool turns the smallest diameter on the work to 0.137 inch diameter. The other diameters are found opposite 0.072 and 0.138, in the column headed No. 0; they are 2.1075 inches and 1.9771 inch, respectively.

\* \* \*

A British contemporary relates the following regarding the opening of the works of the Power Gas Corporation, Ltd., which has just erected a gas plant near Moscow. The ceremony of starting the plant was very impressive. There was a blessing service over the producers and engine; the priests and choir from the church read prayers and sprinkled the engine and producers with holy water and blessed them, and erected an image of a guardian saint over the producers and another one over the engine. The managing director then officially started up the plant before hundreds of spectators, when everything passed off successfully.

\* The table only reads to thousandths of an inch, but values corresponding to ten-thousandths inch can be found by interpolating.

## THE MAKING OF SEAMLESS GOLD WIRE

By CHESTER L. LUCAS\*

Wire, in its various forms, plays an important part in our every day affairs. To the mechanical man, the principles of wire making are generally understood; but in the work of making seamless gold wire for jewelry and optical manufacturing, there are a great many interesting operations that are little understood to those "on the outside." Solid gold wire might be made, of course, by the same methods that are used in making brass or copper wire, and indeed that is the way that very small gold wire is made, but wire of this kind in any of the larger sizes would be too expensive; hence we have seamless gold hollow wire and seamless gold-filled wire.

There are many concerns in the business of making seamless gold wire, but it is doubtful if there are any that have as

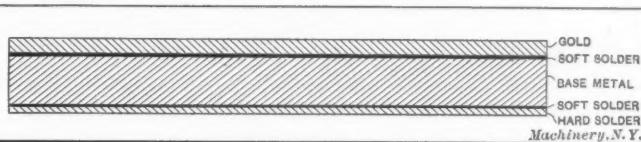


Fig. 1. Construction of the Flat Ingot

good a process or any that are better equipped for doing their work than the Improved Seamless Wire Co., of Providence, R. I. It is to Mr. T. F. Carlisle, president of this company, that credit is due for the courtesy shown the writer while at the factory.

### "Improved" Seamless Gold Wire

The difference between the ordinary seamless gold wire and improved seamless gold wire, lies in the methods used in uniting the gold shell and the base metal, which is used to "fill" the wire. The process of making improved seamless gold wire consists essentially of building up a flat ingot from a layer of gold, a layer of base metal, and a thin layer of hard solder. This metal plate is then reduced in thickness by means of a rolling mill, and from the rolled sheet are cut disks that are afterward drawn into tubes. In order to give the wire strength, a core of base metal is turned up, fluxed and pushed into the shell and soldered in place by means of

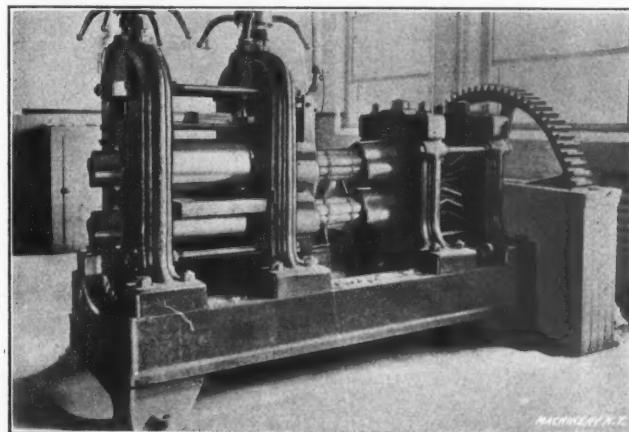


Fig. 2. "Breaking-down" Rolls used to reduce the Metal for Wire-making the solder lining of the tube. This ingot is then made into wire by swaging and drawing.

The principal advantages claimed for this process of wire making are: First, that it perfectly unites the gold covering with the core, making an ingot that can be converted into wire without blistering the outer shell of gold; and second, that with this process it is possible to make gold plated wire whose gold covering is much lighter than that made in any other way.

The above description is given to make clear the fundamental points of the process before going into the details of the various operations employed in seamless gold wire making.

### Preparing and Rolling the Stock for Wire Making

The first step in making seamless gold wire is the preparation of the stock. A block of base metal, as shown in Fig. 1,

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resembling gold in color, and about 2 inches wide by 15 inches long and  $\frac{3}{4}$ -inch thick, is cleaned and fluxed on both sides. On one side is laid a sheet of very thin soft solder and above the solder is placed a sheet of gold, the thickness of which depends upon the quality of wire that is being made. The other side is next covered with another very thin sheet of soft solder, outside of which is placed a sheet of hard solder 0.002 inch thick. These five sheets are clamped together and placed within a furnace and heated sufficiently to allow the

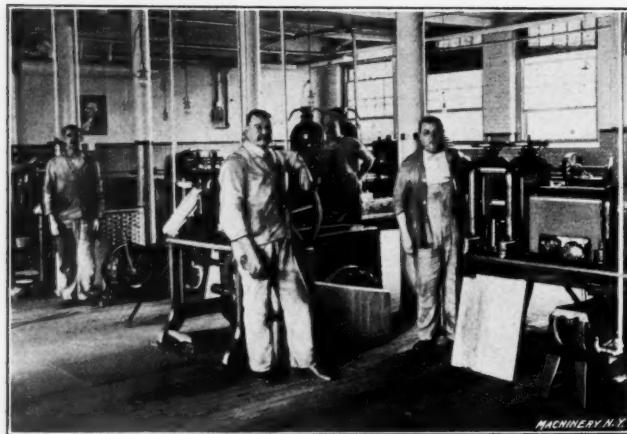


Fig. 3. General View of Rolling Department

solder to fuse and unite the three plates: gold, base metal, and hard solder.

This composite block of metal is then taken to the breaking-down rolls shown in Fig. 2. The rolls themselves are 12 inches in diameter and 20 inches long, and the machine is extremely powerful in design and construction. As in most rolling mills, the weakest parts of the machine are the cast-iron couplings, purposely made so in order that they will break before the rolls themselves, in case they "get a bite." In addition, the necks of the rolls are double, so that they may

a closer view of two of the small rolling mills and is reproduced to show the method of driving the machines by the use of motors and chains. It is stated that by the use of these chain drives, a 90 per cent efficiency is secured, and it is apparent that this method of driving is practically noiseless.

#### Annealing and Trimming

The rolling operations reduce the thickness of the gold in the same proportion that they do the base metal, no matter

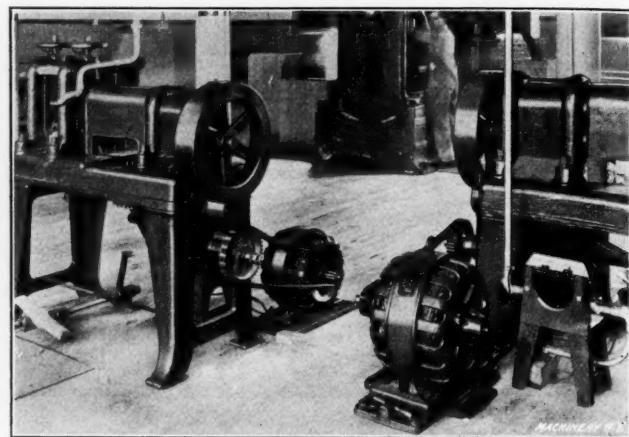


Fig. 4. Method of Driving Rolling Mills with Morse Chains

to what extent the stock is rolled. The hard solder also becomes proportionally thinner. As the metal is rolled, it becomes harder; consequently it is necessary to anneal it between every few operations to prevent the development of cracks and seams that would spoil the stock. The annealing is done in a room that is specially fitted up for the work, in which the light is controlled by adjustable blinds over the windows. Fig. 5 shows two of the furnaces in which the annealing is done, the one at the left being used for the short thick bars in the early stages of the rolling, while the other

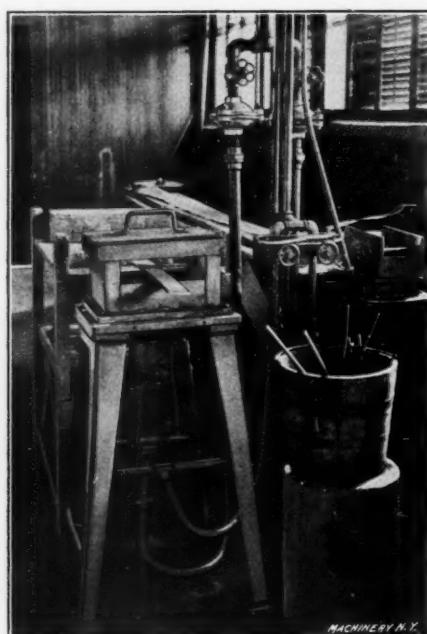


Fig. 5. Annealing Room for Rolled Stock

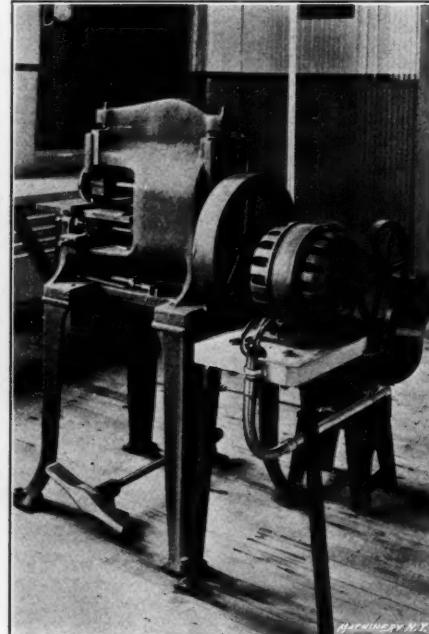


Fig. 6. Backgeared Rotary Slitting Shears

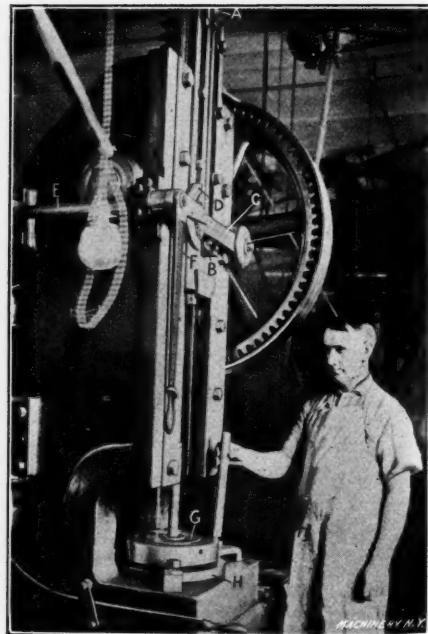


Fig. 7. One of the Special Presses for Tube Drawing

be reversed in case of injury to one end. Here the stock is rolled down to No. 6 B. & S. gage, reducing it approximately 0.100 inch at each pass.

A good deal of rolled plate is made by the Improved Seamless Wire Co. for other purposes than wire making, and when the stock is to be rolled thin, it is passed from the breaking-down rolls to a 5 by 8-inch Mossberg rolling mill, where it is reduced to No. 24 B. & S. gage, after which it goes to a 4 by 6-inch rolling mill and is further reduced to any desired thickness. Fig. 3 shows the rolling department with the 5 by 8- and the 4 by 6-inch mills in the foreground. This room is a model of cleanliness for a rolling department. Fig. 4 shows

furnace is the one employed for the long thin strips that come with the last rolling operations. Before being placed in the fire, the strips are painted with a thin coat of brown ochre and boracic acid. This coating prevents the formation of scale while the stock is being heated. The strips are passed through the furnaces, being kept slowly moving to allow every part of the metal to reach the low red heat at which the best results are attained. In this room are also located the pickling baths of diluted sulphuric acid and the sawdust boxes for drying the stock after pickling.

As the thickness of the metal is reduced by the rolling, the length of the strip greatly increases. The width of the metal

also increases, but to a much smaller degree. The edges of the strip take on an irregular and ragged appearance, and often when the rolling strains are taken out by the annealing, the strip becomes "kinky" and warped. For these reasons the strips must be trimmed after each annealing and this part of the work is done on the rotary slitting shears shown in Fig. 6. An interesting feature of this machine is the method of applying the motor drive, the motor being back-gearred to adapt the speed of the motor to the machine. It is on this machine, also, that the strips for the wire making are finally cut to 7-inch squares preparatory to the drawing operation.

#### Drawing the Tubes

One of the most interesting parts of seamless wire making is the making of the tubes from which the wire is drawn. The 7-inch squares of rolled plate stock, the making of which has just been described, are first trimmed into disks by an ordinary blanking die, after which they are ready to be drawn into tubes, by means of special presses, one of which is shown in Fig. 7. These presses were made by the Waterbury Farrel Foundry & Machine Co. and differ essentially from the ordi-

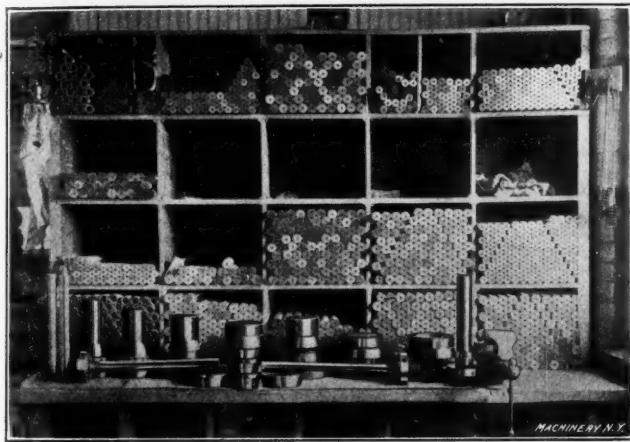


Fig. 8. Rack of Cores and Set of Dies for the Tube Drawing

nary drawing press in that they have an extra long stroke actuated on the rack-and-pinion principle, and an automatic trip and reverse. The press is fitted up with speed changing gears to accommodate the conditions involved in drawing the various sizes of tubes. The length of stroke is determined

by setting the adjustable dogs, *A* and *B*, in the T-slot in the ram. As the ram descends, dog *A* approaches swinging arm *C*, and pushes it down as they meet. This movement causes the knob at the lower side of the arm to push the rocker arm *D* downward, thus turning the shaft *E* which is connected with the belt reversing mechanism. If it is necessary to check or reverse the movement of the ram at any point between the points set by the dogs, it is only necessary to operate the rocker arm by means of the hand lever *F*. As the work done in these presses is all cylindrical in form, it is an easy matter to hold the punches and dies. The punches are made with a shoulder and a threaded shank that screws up into the headlock of the ram, while the dies are merely laid upon the die shoe *H* that is kept clamped in place on the bed of the press. This die shoe has a threaded shoulder over which clamping ring *G* is screwed, the tapered opening in this ring pulling down on the corresponding taper on the dies themselves.

The first operation in making the tubes after the 7-inch squares have been trimmed to disks is to draw the disk into a cup about 5 inches in diameter and 1½ inch deep. The

Fig. 9. Sectional View of Completed Tube with Core Inserted

shoulder over which clamping ring *G* is screwed, the tapered opening in this ring pulling down on the corresponding taper on the dies themselves.

The first operation in making the tubes after the 7-inch squares have been trimmed to disks is to draw the disk into a cup about 5 inches in diameter and 1½ inch deep. The

blanks are laid on the die with the gold face down, so as to have the gold plate on the outside of the tube and the thin, hard solder lining on the inside. Next, this shell is run through a die which transforms it into a deeper shell that is smaller in diameter. This process is repeated, drawing the shell through eleven dies in all, each of which makes the shell, or tube as it finally becomes, still deeper and narrower. The finished tubes are 1¼ inch in diameter and 14 inches

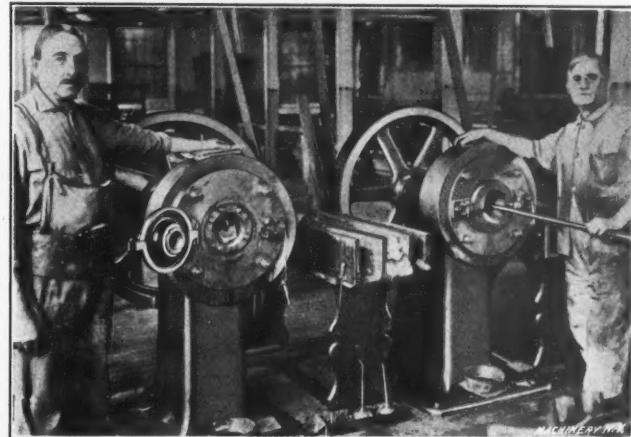


Fig. 10. Starting Solid Gold Wire in the Large Swaging Machines

long. The perimeter of the blank at the beginning was 22 inches, while the perimeter of the top of the finished tube is only about 4 inches.

The rack in Fig. 8 contains over a thousand cores. These cores are of different base metals to match the particular kind of shells that they are to go within. The cores are thoroughly cleaned, fluxed, and then pushed into the shell. After coating the exterior of the shell with yellow ochre and boracic acid, the shell and core are heated hot enough to flow the hard solder lining, thus firmly uniting shell and core. As it requires a good red heat to flow hard solder, the gold would easily scale if it were not for the yellow ochre and boracic acid protection. The tubes for hollow wire require no cores, except in special wire, in which hollow cores are inserted to

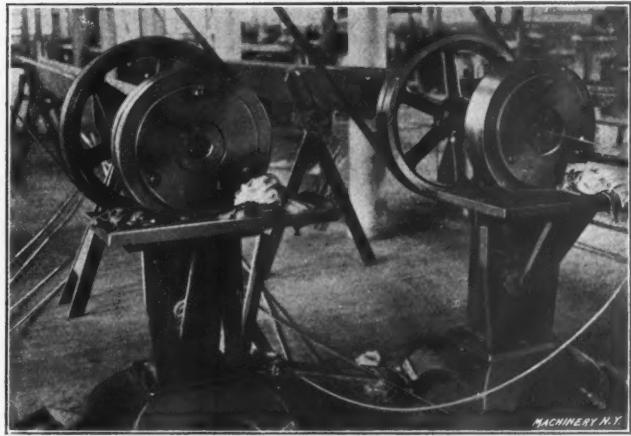
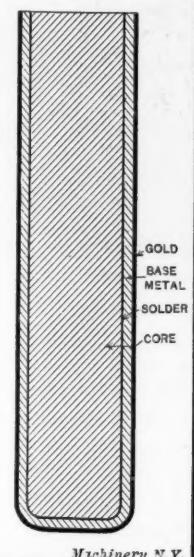


Fig. 11. Two of the Small Swaging Machines

give the necessary thickness to the walls of the tube. Fig. 9 shows the completed tube and core in cross-section.

On the bench in the illustration Fig. 8, appears a set of the punches and dies for preparing tubes for seamless wire ingots. As with other drawing operations, the tubes must be annealed after passing through every third die. At the extreme left of the bench is a completed tube that has been trimmed, and beside it is a tube with the core soldered in place.

The importance of this method of applying the hard solder to the metal should not be overlooked: First, because the application of the solder is uniform; second, it is economical, requiring much less solder than would be used by any other method; and third, on account of the method of application the joint is much stronger than the average soldered joint. It should be possible to apply this kink to other lines of manufacturing that require good hard soldering.



#### Starting the Solid Wire

We must now divide our attention for a while over the two divisions of the wire—the solid and the hollow varieties—for the methods of roughing down in size vary, although the finishing operations are the same. Fig. 10 illustrates two of the Excelsior swaging machines that are used to reduce the bars to somewhere near the finished size of the wire. The operator in the illustration is just starting through for the second time a bar of solid 10 carat gold, which is to be made into very small wire. The machine at the left is shown with the front plate thrown open. Within the opening may be seen one die of the pair. In a nearby rack are sets of dies for all sizes between  $\frac{1}{4}$  and  $1\frac{1}{2}$  inch. After passing through the machine, the rod is slid back in the trough between the machines, and sent through for another reduction. After the rods reach the  $\frac{1}{4}$ -inch size, they are passed along to the smaller swaging machines shown in Fig. 11. These machines reduce the wire very nearly to the size that it is to finish. As with the rolling and drawing operations, swaging hardens the stock that is being worked; therefore, frequent annealing is necessitated. This operation is done in the wire

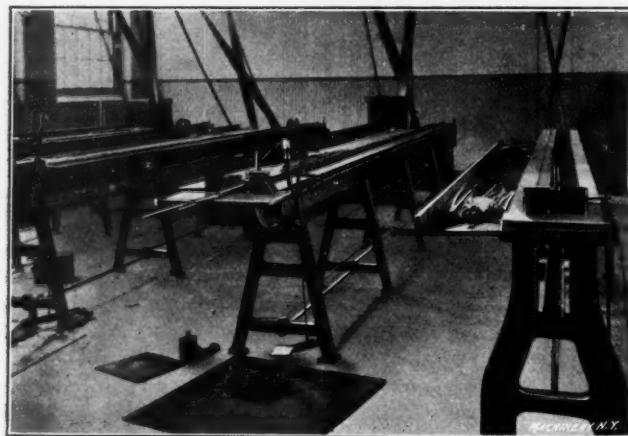


Fig. 12. Draw Benches for Starting the Hollow Gold Wire

annealing room, in which are located special furnaces and pickling baths, very similar to those described in the stock rolling room. After passing through the small swagers for the last time, the solid wire is ready for the finish drawing. Leaving it at this stage, we will take up the first operations in making the hollow wire.

#### Starting the Hollow Wire

In making the thin hollow wire, the tubes are trimmed after being drawn and then annealed. Fig. 12 shows the set of draw benches that are used to start the tubular or hollow wire. In their rough state, the tubes are  $1\frac{1}{4}$  inch diameter and 13 inches long. First, a  $\frac{3}{8}$ -inch hole is drilled centrally through the bottom of each tube. Next the tube is slipped over a 1-inch arbor, one end of which has been turned to  $\frac{3}{8}$

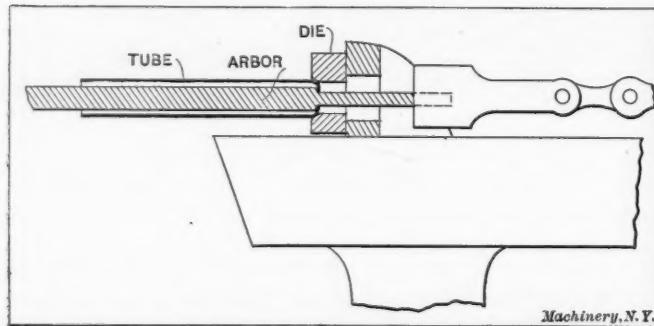


Fig. 13. The Way the Hollow Wire is started

inch for a distance of 3 inches. This  $\frac{3}{8}$ -inch end projects through the hole in the tube. The arbor is now placed over the die plate on the draw bench, with the small end reaching through the die. The jaws of the carrier come forward, grip the arbor by the  $\frac{3}{8}$ -inch section and thus the arbor and tube are pulled or drawn through the die. This operation is best explained by the illustration Fig. 13 in connection with Fig. 12, in which the second draw bench from the right is shown

about to start the forward stroke. Each drawing operation reduces the diameter of the tube by about  $1/16$  inch. By means of these draw benches, the tubes are reduced to  $\frac{1}{4}$  inch diameter and the length, of course, increased to from 20 to 30 feet.

#### Finishing the Wire

Fig. 14 illustrates the operation of finishing the wire of both kinds, solid and hollow. These draw benches are of

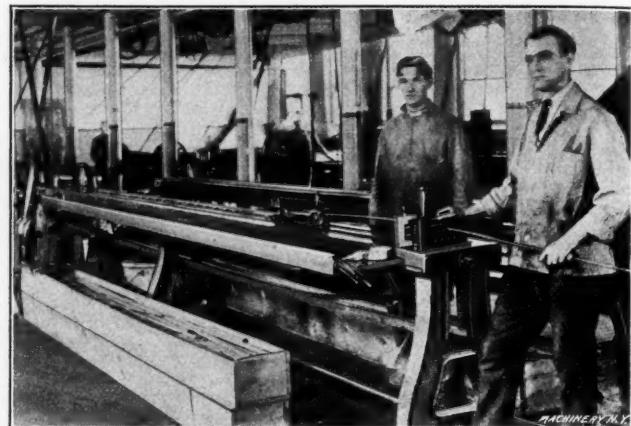


Fig. 14. Finishing the Wire

the same design as the ones used to start the hollow wire, but they have a capacity for handling 30-foot lengths of wire. The dies for the finish drawing resemble thick drill gages, for they have a series of 20 holes, ranging from  $\frac{1}{4}$  down to 0.040 inch. This latter size is the smallest wire made by the company. The dies naturally receive very hard wear; but in spite of this fact, the 20-hole dies "stand up" for a long time, averaging about a year apiece. As with the pre-

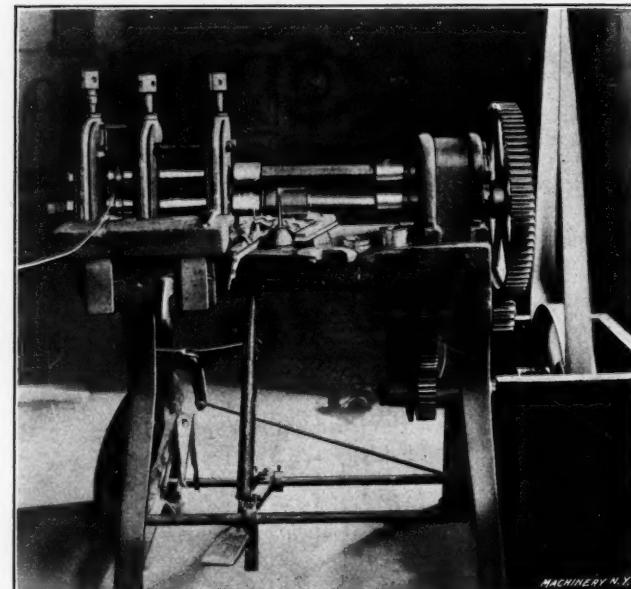


Fig. 15. Shaping the Wire to Special Sections

vious operations of rolling and swaging, annealing is necessary in the wire drawing. Between every ten "numbers," as the operators express it, annealing is required. As will be noticed in the illustration Fig. 14 the operator of the draw bench stands at the head of the machine, within easy reach of the starting lever. As the wire passes through the die he guides it and at the same time lubricates it with a pad that is kept soaked with lard oil.

The solid and hollow wire are both finished in the same way. If the wire is to be used for optical work, such as bows or other spectacle parts, the annealing is less frequently done, so as to produce a wire that is tough and hard. Silver wire is very easily drawn, but as the demand is small, very little of this product is made.

#### Special Wire Sections

We are apt to think of gold wire as wire of a simple round section, yet the Improved Seamless Wire Co. makes hundreds of different styles and sizes in round, flat, square, oval and

other fancy shapes, plain as well as embossed, or knurled with different patterns. We have followed, step by step, the various operations in making the plain round wire; let us now consider the method of producing the various shapes and finishes that part of the wire assumes.

In Fig. 15 is shown a corner of the room in which the wire is shaped to special sections, and embossed as required. The rolling mill in the foreground is one of several that are used for this special rolling. This machine is shown converting round gold filled wire into a half-round wire that will later be made into wedding rings. This operation is a simple one, and by substituting rolls with different shaped grooves, flat, square or in fact nearly any section may be rolled.

The fancy wire is produced by the use of knurls or embossing rolls. Many kinds of ornamented wire are made for

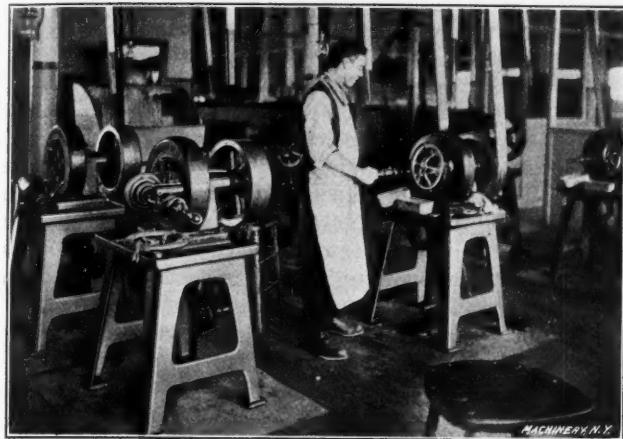


Fig. 16. Langelier Swagers for Ring Shank Making

jewelry and decorative work and some of the knurls are very elaborate. In view of this fact, it is often that the engraving of a pair of knurls amounts to thirty or forty dollars. It will be easily understood, therefore, that the collection of knurls used in this department is very valuable, and for this reason they are kept in the fire-proof safe shown in the background of Fig. 15. The value of this collection of knurls is roughly estimated at three thousand dollars. It must be borne in mind that throughout all the operations of making, forming and embossing the wire, the outer covering of gold is undis-

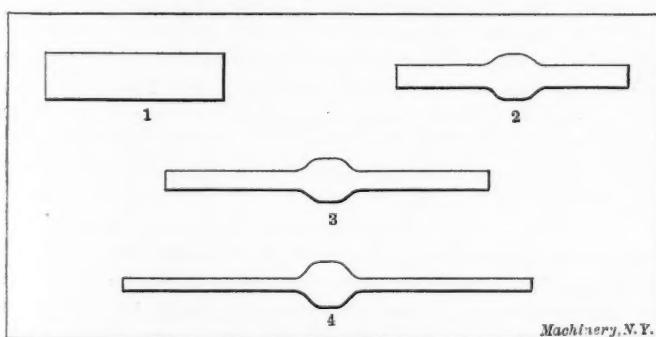


Fig. 17. The Evolution of a Ring Shank

turbed, as regards its thickness in proportion to the total wire diameter.

#### Making Ring Shanks

Another interesting department in this factory is the one in which ring shanks are made. A "ring shank" is distinctly a manufacturing jeweler's term, and is defined as a piece of stock from which a ring is made; at the center, the metal is thick and spherically shaped. This part is to become the setting, while the ends that are to be bent to form the band of the ring, are small in diameter. The illustration Fig. 17 conveys a good idea of a ring shank, although ring shanks are made in a great many different sizes and styles. The round seamless wire about  $3/16$  inch in diameter is cut off in what seems to be very short lengths, about  $3/4$ -inch long. Fig. 16 illustrates a group of the Langelier swagers that are employed to reduce the ends of the blanks for the ring shanks. Each end of the blank is reduced in from three to five oper-

ations, varying with the size ring shank being made. Fig. 17 shows four successive stages of this swaging operation.

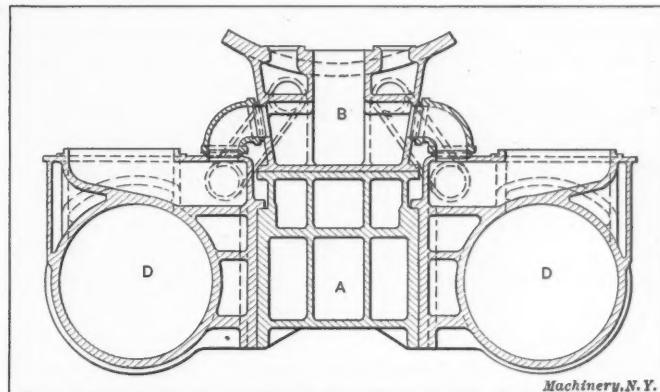
The completed ring shanks still retain their covering of gold plate. In this state they are furnished to the ring manufacturers, who emboss them under the drop hammer, bend them to shape, solder and finish them for the retail trade—an interesting evolution from a piece of sheet metal.

\* \* \*

#### LOCOMOTIVE SADDLE AND CYLINDER ARRANGEMENT

A new type of locomotive saddle and cylinder arrangement is embodied in U. S. Patent Number 975,183 (November 8, 1910) taken out by Samuel M. Vauclain, of Philadelphia, assignor to Baldwin Locomotive Works, of Philadelphia, Pa. The cylinders in place of being cast with a half saddle, are made separately, with an intervening part, on top of which is the saddle, as shown by the accompanying engraving. The main object of this arrangement, is that the parts may be more readily handled, thereby facilitating repairs when necessity should arise, and a further object is that the frame *A* might be made of steel and the saddle *B* of cast-iron, the cylinders castings *D* being made separate and bolted to the steel frame, thereby making a substantial structure.

The main frame *A* is ribbed for strength and has arms projecting forward and backward, which are bolted to the loco-



New Arrangement of Cylinders, Frame and Saddle

motive frame, making a more rigid construction, which is not only stronger, but also forms a very substantial support for the front end of the boiler.

As illustrated, the exhaust passages form separate elbows, but, in connection with this patent, there are drawings illustrating a locomotive with the exhaust passages through the central frame *A*. Other drawings illustrate the application of this new construction to piston valve engines.

\* \* \*

One of the most interesting alloys is that known as "monel-metal." It consists of copper and nickel, but is not made from melting these two constituents and mixing them together. Instead monel-metal is a so-called "natural" alloy, being made from a copper and nickel ore, no attempt having been made to separate the two metals. As the cost of producing either nickel or copper for these ores becomes very high, the curious condition is produced that monel-metal sells at a cheaper price than either of the two metals, nickel and copper, of which it is composed. Were it possible to profitably separate the nickel and the copper in the monel-metal ore, this metal would at once rise in price. The composition of monel-metal varies somewhat. It contains usually from 24.75 to 26.5 per cent of copper, from 70 to 74 per cent of nickel and from 0.5 to 5.25 per cent of iron.

\* \* \*

The City of Liverpool is planning to construct a new dock 1020 feet long with an entrance 120 feet wide, capable of holding four ships 1000 feet in length. It is generally supposed that this development is intended to provide accommodations for the new mammoth Cunard liners of which much has been spoken, but about which little definite information has as yet been obtained.

## THE FILING AND INDEXING OF ENGINEERING DATA\*

By CHAS. G. MAHANA†

The question of how to index and file engineering data is often a perplexing one. An efficient filing system means a much more extensive use of the data collected, with the corresponding benefits of such use. The larger the collection of data, the less use will be made of it, if it is not filed and indexed in some convenient way. The system of filing must make it easy to find the articles or data collected on any particular subject, and yet it must be so simple that the indexing does not consume too much time. The system described in this article is extremely simple and efficient; there is very little labor connected with keeping it up to date; and the data collected on any subject may be almost instantly located.

Manila envelopes of the thickness known as "40-pounds," 6½ inches by 9½ inches in size, open at one end and with the flap removed, are used for filing the larger part of the articles and similar data. These envelopes are a stock size and may be purchased for about fifty cents for two hundred. As most technical magazines are nine inches by twelve inches, or close to those dimensions, pages which it is desired to save can be removed from the magazines, folded once, and the envelopes are just the proper size to receive them. The envelopes are then filed exactly as if they were cards in a card-index system; that is, an envelope containing an article on valves is marked "Valves" in the upper left-hand corner, and filed alphabetically with the other envelopes in a card-index cabinet.

As many articles as desired may be placed in one envelope, so long as it is not filled so full as to bulge and partake of the nature of a package more than of a card. As many envelopes bearing the same title may also be used, of course, as desired, as they will all be located together in the file, and when one is found all are found. As much descriptive matter of the contents of the envelopes may be added as one sees fit. For instance, there may be several envelopes each containing one or more magazine articles and other data on cylinders. The titles of the various envelopes may then be made to read, "Cylinders, Air-cooled"; "Cylinders, Two-cycle"; "Cylinders, Machining"; "Cylinders, Offset"; etc.

Index cards 6½ inches by 9½ inches are also used and are filed with the envelopes the same as if all were cards. Guide cards are also used. The index cards are used for cross-references, indexing of short clippings, and the indexing of data which it is impossible, or at least impracticable, to cut out and file in the envelopes. Data in books and similar places may be indexed on the cards, or, if short, may be written on a card and put in the file. If desired, of course, longer articles may be typewritten on paper and put into envelopes.

Short clippings are either copied on cards or pasted on cards and indexed. It often happens that in magazines a short article will occupy small portions of two or more columns, as for instance when it begins at the bottom of one column and ends at the top of the next, and an illustration or two may appear in other columns, or possibly on the next page. In such a case it is most convenient to cut out the various portions and paste them together on one card for use in the file.

For cross-references, the cards are used in the same manner, of course, as in any card index. It seldom happens that two articles on different subjects, which it is desired to save, appear on the same leaf of a magazine, but when they do or when an article treats of more than one subject, cross-reference is provided for as follows: In the first place, all cards and envelopes are numbered in the upper left-hand corner. These numbers are merely for the ready identification of any particular envelope or card, the envelopes and cards being filed alphabetically, and not numerically. The writer simply numbers a supply of blank cards and envelopes at a con-

venient time, and uses from that supply until they are exhausted, paying no attention to whether they are used in numerical order or not.

If an article on pistons should appear on one side of a sheet and an article on frames on the other, and it were desired to index both of them, it would be done by enclosing the clipping in an envelope indexed under one of the titles, "Piston," for instance, and the number in the corner of the envelope, "314," for instance, would be inclosed in parentheses. Parentheses around a number signifies that there is a clipping in that envelope treating on more than one subject and indexed under more than one title, and that no other clippings are ever to be put into that envelope. A card would then be written under the title of "Frames" and with a reference to the envelope as follows: "See Pistons, 314."

Suppose now that we are looking for data on frames. We refer to our file and find the card just described, referring us to "Pistons, 314." We turn to "Pistons" and find perhaps ten or twelve envelopes under that head, some of them containing several articles. We do not have to look through all of the envelopes and all of the clippings to find the one on which also appears an article on frames; we simply select the envelope bearing the number 314, and we know that that envelope contains the clipping we want and no others. Every time we have had a clipping on pistons to file, the parentheses around that number 314 has warned us not to put it into that envelope.

From the description given, it will be seen that the clerical work involved in indexing is very small. Often there is nothing to do but cut out the article and put it into one of the envelopes already indexed, there being no writing to do at all.

If an article takes more than one sheet, the sheets should be fastened together by pasting at one corner. If in later issues of the magazines, discussions, corrections, or future installments of the article appear, they may be attached to that which has already been filed. This feature is one of the valuable points of the system. In a bound volume of a magazine, the various installments of an article, and the corrections and discussions, if any, are scattered all through the book, and sometimes through two or three, while with the system described above all are gathered together in one envelope and all other articles relating to the same subject are in adjacent envelopes.

Bound volumes are heavy and bulky to handle for reference, and it is extremely inconvenient for one to carry data to his home or to the office if it is contained within two or three bound volumes of a nine-inch by twelve-inch magazine.

The fact, too, that obsolete or out-of-date matter can be so easily weeded out is an advantage over bound volumes. Valuable room is often taken up on the book shelves by old volumes of a magazine for the sake of only half a dozen articles worth saving. If the magazines are torn apart and the valuable articles filed about as fast as they are received, the filing system is always up to date. The new live matter is in the files where it may readily be referred to, instead of being stowed away in a pile of unbound magazines waiting to go to the bindery, or at the bindery, waiting to be bound and returned. The value of the magazines one takes is more than doubled, because every article considered worth saving, even for a short time, is at one's finger tips.

\* \* \*

The February issue of *MACHINERY*, engineering edition, contained a brief item relating to the loss of power in gas engines, due to elevation above sea level. The statement made to the effect that about 1 per cent of the indicated horsepower was lost for each 1000 feet increase in elevation, was based upon an article in an English contemporary. This has been corrected by the journal publishing the original article, and the loss instead amounts to not less than about 3½ per cent for each 1000 feet increase in elevation. This agrees also more nearly with the experience of makers who have roughly allowed about 2½ to 3 per cent for each 1000 feet of elevation.

\* See *MACHINERY*, January, 1911, "The Systematic Scrap-book."

† Address: Three Rivers, Mich.

## A NEW CIRCULAR-ARC ELLIPSE CONSTRUCTION

By H. A. S. HOWARTH\*

So far as the writer knows there has been, heretofore, no very satisfactory way to draw an ellipse by a two-arc construction. There are a few methods given in handbooks and works on mechanical drawing, but they are useful only for a small range of proportions. The following method is believed to be new, and it is surprisingly accurate for all proportions. This is due to the fact that the point where the two arcs join is on the exact ellipse and is so chosen that the shorter of the two arcs will pass exactly through the ends of the major axis for some proportions and *almost* exactly through them for others. The error is practically negligible.

The method is as follows: In Fig. 1,  $AB$  and  $CD$  are the axes of an ellipse, and  $O$  is their intersection. The minor axis  $CD$  is drawn long enough to contain the center  $S$  which is to be found. Lay off the distance  $OE$  equal to  $OA$ . With  $E$  as a center draw the arc  $OHG$  having the radius  $OE$  equal to  $OA$ . Parallel to  $AB$  draw  $CH$  cutting this arc at  $H$ . Through  $H$  draw the radial line  $OHJ$ . It will be noted here that the in-

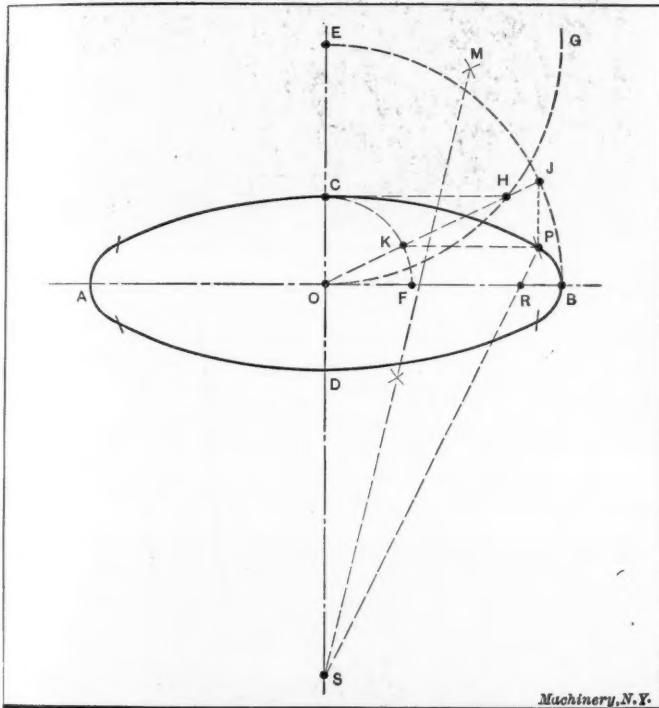


Fig. 1. An Accurate Method for Constructing an Ellipse by Circular Arcs

clination of this radial line depends upon, and varies with, the width of the ellipse. It is this fact that makes this method suitable for ellipses of all proportions.

With  $O$  as a center, draw the arcs  $CKF$  and  $EJB$ , cutting the radial line  $OH$  at  $K$  and  $J$ . Draw  $KP$  parallel to  $AB$ , and  $JP$  parallel to  $CD$ . They will intersect at a point  $P$  which is a point on the *true* ellipse. Having this point  $P$ , it is only necessary to find the center  $S$  so that an arc may be drawn from  $C$  to  $P$ . To find this point, draw the line  $MS$  so that it bisects and is perpendicular to a line drawn from  $C$  to  $P$ . Point  $S$ , where  $MS$  cuts the minor axis, is the required center.

Having  $S$ , draw  $PS$  cutting  $AB$  at  $R$ . Taking  $R$  as a center and  $PR$  as a radius the arc  $PB$  may be drawn. Since the centers  $R$  and  $S$  are on the same line as  $P$ , the two arcs will meet perfectly at  $P$ . The whole ellipse may now be drawn easily if short arcs, centered at  $O$ , are first drawn, cutting through  $P$  and the three other points where the curves meet. These are indicated in Fig. 1. Fig. 2 shows an ellipse of other proportions drawn by the same method. Both ellipses are evidently satisfactory and quite pleasing to the eye.

The question which now remains is: Does an arc with a radius  $PR$  and a center at  $R$  pass exactly through the end of the major axis at  $B$ ? A careful construction of a number of

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ellipses failed to show any error other than that which would be expected on a drawing board. Hence the matter was investigated mathematically. Fig. 2 is constructed like Fig. 1, with the addition of some lines required for the mathematical analysis. The point  $B$  is assumed to be the end of the major axis, and  $P$  is a point on the true ellipse, determined by this new construction. The error of the method will be the difference in the lengths of  $PR$  and  $BR$ . Hence,

$$\text{Error} = PR - BR.$$

If the ratio of the minor to the major axis be taken as  $r$ , and half of the major axis be taken as unity, then half

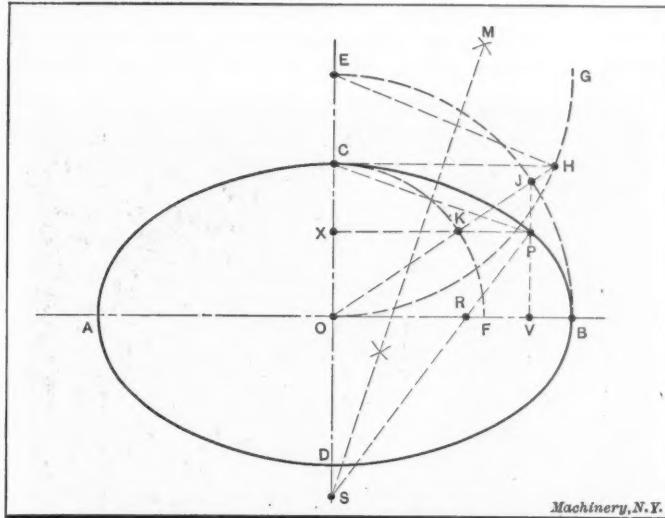


Fig. 2. Method applied to Ellipse with Less Difference between Major and Minor Axis than that in Fig. 1

of the minor axis will equal  $r$ . That is,  $OB = 1$  and  $OC = r$ . Draw  $EH$ . By construction it equals  $OB$  and that equals unity. Also we have  $EC = OE - OC = 1 - r$ . It is evident that  $CH$  may now be found in terms of  $r$ . Hence  $OH$  may be found. The triangles  $OCH$ ,  $JPK$  and  $JVO$  are similar. By continuing the use of simple geometry, expressions may be found for both  $PR$  and  $BR$  in terms of  $r$ .

By the use of a formula deduced from those simple geometrical relations, the following errors were found:

When $r = 0.00$ , the error =	0.0000
$r = 0.06$ , the error =	-0.0058
$r = 0.10$ , the error =	-0.0062
$r = 0.20$ , the error =	-0.0040
$r = 0.40$ , the error =	+0.0023
$r = 0.50$ , the error =	+0.0040
$r = 0.60$ , the error =	+0.0043
$r = 0.80$ , the error =	+0.0021
$r = 1.00$ , the error =	0.0000

Where the error is positive,  $PR$  is greater than  $BR$ , and the smaller arc would pass slightly beyond the end of the major axis. Where it is negative,  $PR$  is less than  $BR$ , and the smaller arc would pass slightly within the end of the major axis.

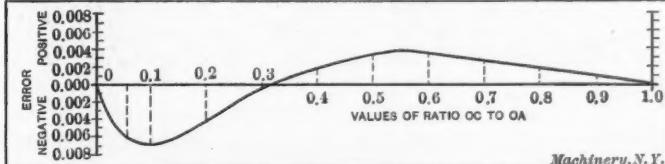


Fig. 3. Diagram showing the Limits of the Errors introduced by the Method for Drawing Ellipses

When the major axis is two inches long the above errors obtain, and the variation is from zero to 0.006 inch. Since the sign of the error changes from plus to minus as  $r$  decreases from 0.4 to 0.2 there must be a value of  $r$  in the neighborhood of 0.3 at which the error is zero. This value of  $r$  may be found by drawing the curve shown in Fig. 3. The abscissas are values of  $r$  and the ordinates are the errors. The curve cuts the straight line at about 0.32, and for this value of  $r$  this new method is very exact.

The maximum negative error (0.0063) occurs when  $r$  is about 0.08, i.e., when the ellipse is about twelve times as long

as it is wide. This very narrow proportion is seldom met with. The maximum positive error (0.0045) occurs when  $r$  is about 0.55. This is a common proportion, but an error of 0.0045 is negligible on small constructions. It must be remembered, however, that the errors are proportional to the size of the ellipse. If the major axis is 20 inches instead of 2 inches, and the minor axis 11 inches instead of 1.10 inch, the error will be ten times as great, *i. e.*, it will be 0.045 inch.

Persons who may have occasion to use this construction for large ellipses will appreciate its value in locating very closely the useful center  $R$ . One advantage of the method, in addition to its accuracy, is its applicability to *all proportions*. In fact, the curves so closely correspond to the theoretical ellipse (which cannot be drawn by circular arcs) that they are an excellent substitute for it. There are a few three-arc methods

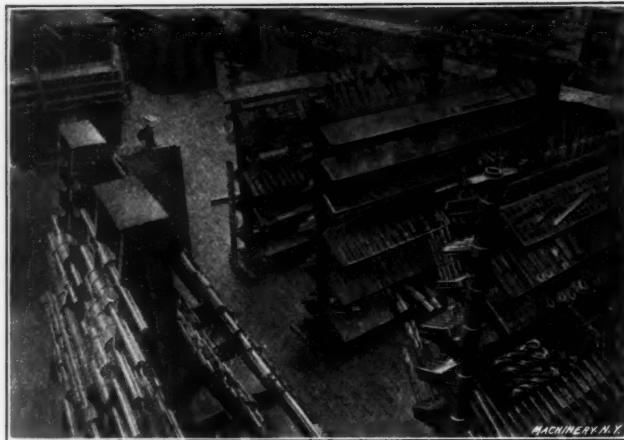
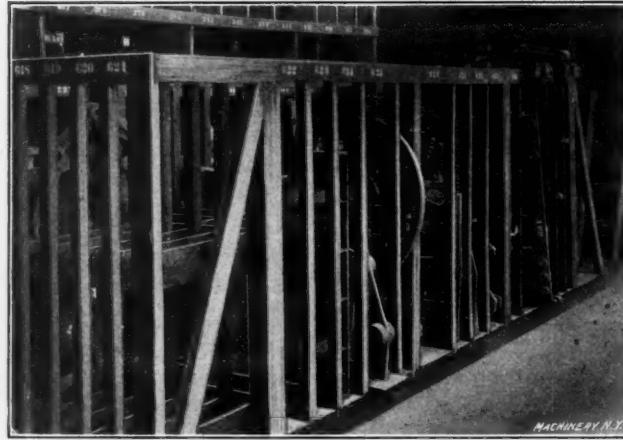


Fig. 1. General View of Toolroom, showing Racks and Tools

that give very good results, but the constructions are complicated. Hence, this new two-arc method should find favor among those accustomed to the more complex three-arc construction.

\* \* \*

The energy with which the German manufacturers and engineering firms are acquiring business all over the world is well exemplified by the combination of twenty German machine manufacturers and engineering firms which are to es-



the building being devoted to the radial drills. The front half of the building has practically no machinery, that part being left for extensions.

#### The Toolroom

The toolroom has every case, rack and convenience needed to make it of the best. Fig. 1 shows a few of the tool racks and cases; taps, drills and reamers are at the right, and large reamers and boring bars at the left. A point well worth noting is that drills, reamers and taps which are within certain

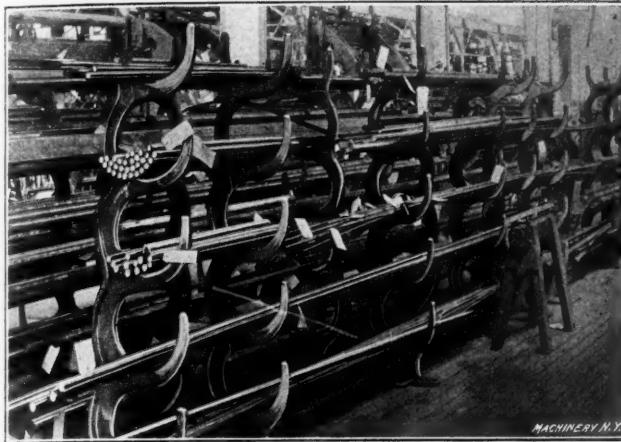


Fig. 5. Cast-iron Stock Racks

sizes, all have interchangeable shanks fitted to them, and in this way by using a driving socket of the correct size changes of tools in the spindle of the drill press may be made with a minimum loss of time. In this connection, there is another interesting feature; all machine taps are made 0.004 or 0.005 inch small so that when the holes are re-tapped with a hand tap it cleans up nicely and makes a good fit. All machine taps are fitted with straight shanks of a certain size, as just stated, so that the machinist has no trouble in distinguishing between the ones used by hand and those intended for the machines.

Stock that is being sent through the shop is first given a

stock order number and a piece number which are put on one side of a red tag, which has on it, in addition, the name of the piece, the quantity to be finished, the number of the drawing and the date on which the lot was started. On the reverse side of this tag are given the various operations through which each piece must go, and in case it is a machining operation the job name is followed by the number of the machine on

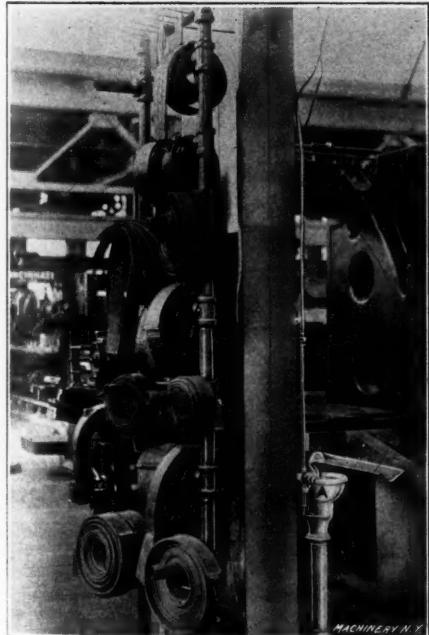


Fig. 6. Belt Rack and Drinking Fountain

which the operation is to be done. This machine number is followed by the number of the jig shelf on which the tools used on the machine are stored.

A row of jig shelves is shown in Fig. 2, and in each is a set of tools and jigs for the job indicated by the number on the outside; and the set used for any particular operation is easily found by means of the jig shelf number on the stock card. Some of the large jigs are stored as shown in Fig. 3, and gages and blueprints as in Fig. 4. The blueprints shown in the engraving are all mounted on tin and are in compartments so

as to be checked out the same as a tool, little hooks being screwed in just over each compartment on which to hang the checks.

Bar stock of all kinds is stored in convenient places in the shop on the cast-iron racks shown in Fig. 5, and in Fig. 6 is a belt rack made of pipe. At A in this engraving is a sanitary drinking fountain, which is one of many in the shop, and is a means of furnishing clear, cool, running water, to the men without the necessity of using a cup.

In Fig. 7 is shown a corner of the gear cutting department, with a Gould and Eberhardt machine at A, another at B and a gear cutter board at C, while at D is shown a first-class way to keep the gages used in setting the machine.

Large jigs, used when boring out the holes in planer beds for the bull wheel and pinion driving shafts, are mounted on three-wheeled trucks as shown in Fig. 8, so as to be easily moved to any desired location. In Fig. 9, one of these jigs

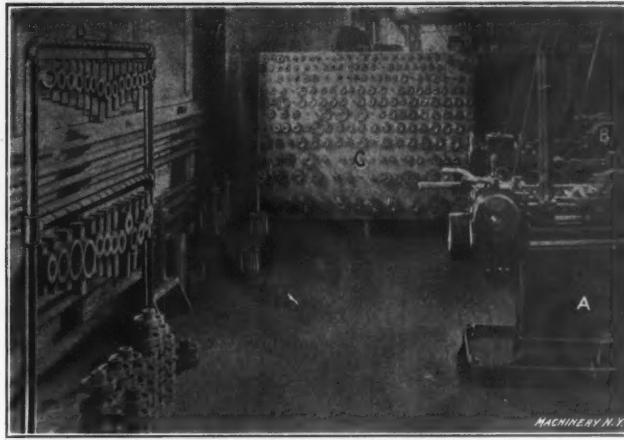


Fig. 7. Gear Gage and Cutter Racks

is shown in use. The jig itself is located in and clamped securely to the finished V's of the planer bed. The boring bars used in this, as well as in all other jigs, where it is possible to do so, are supported by guide bushings at both ends in accordance with the best shop practice.

#### Interchangeable Jigs for Housings and Beds

A very practical and ingenious set of interchangeable jigs is in use for locating the holes in planer housings and beds, whereby the holes are absolutely sure to line up properly when the two parts of the planer are put together. Fig. 10 shows one of these jigs ready to be placed on the base of a housing. The jig is located by placing the tongue blocks A and B in the grooves C and D and pushing it along until stop pin E comes in contact with the finished front, F, of the housing. Fig. 11 shows the jig in position. In use, of course, the housing and jig lie flat; they are placed as shown in order to be photographed more easily. Fig. 12 is the same jig ready to



Fig. 8. Large Jig Trucks

apply to the side of a planer bed, the locating being done by means of the tongue blocks which fit into grooves in the bed at A and B, and the stop C butting against D. Fig. 13 shows the jig in place.

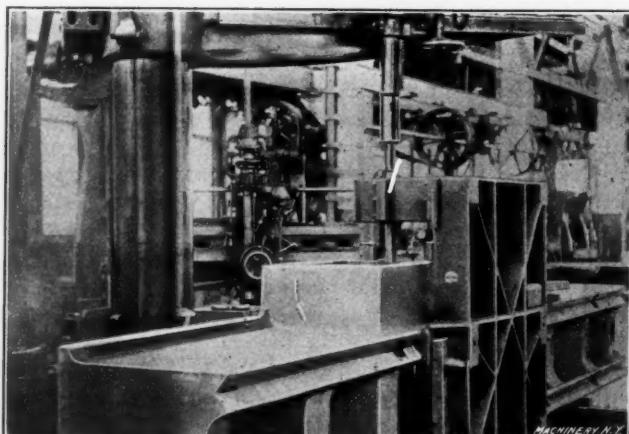


Fig. 9. Planer Bed Jig

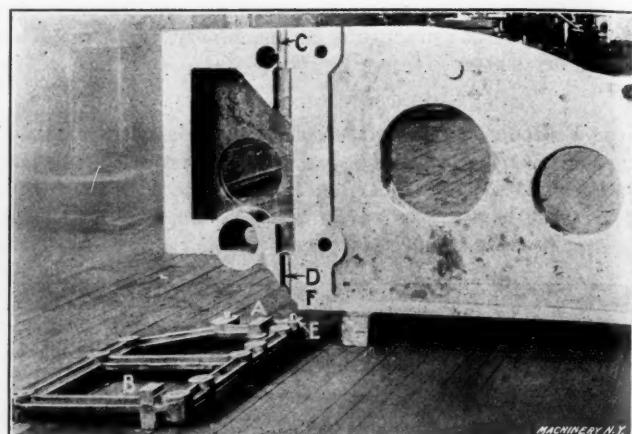


Fig. 10. Housing Base Jig

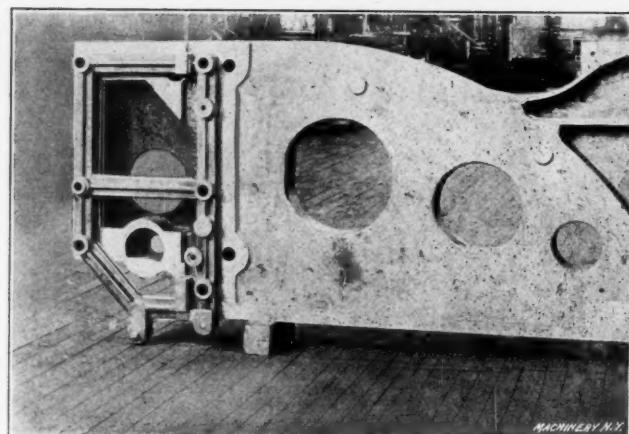


Fig. 11. Housing Base Jig in Place

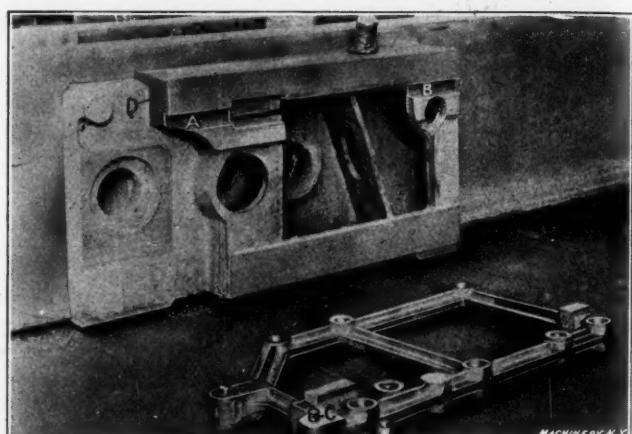


Fig. 12. Housing Base Jig ready to place on Bed

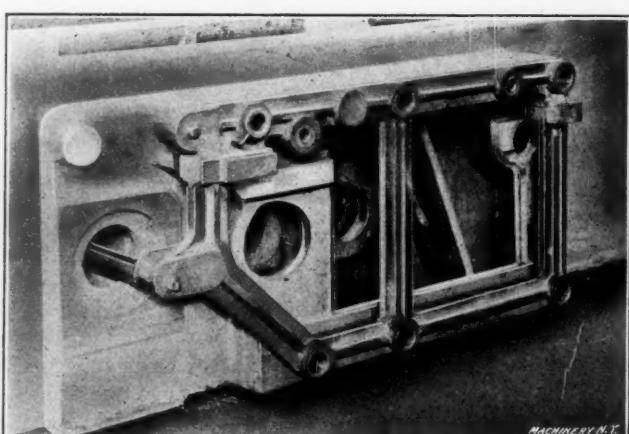


Fig. 13. Housing Base Jig in Place on Bed

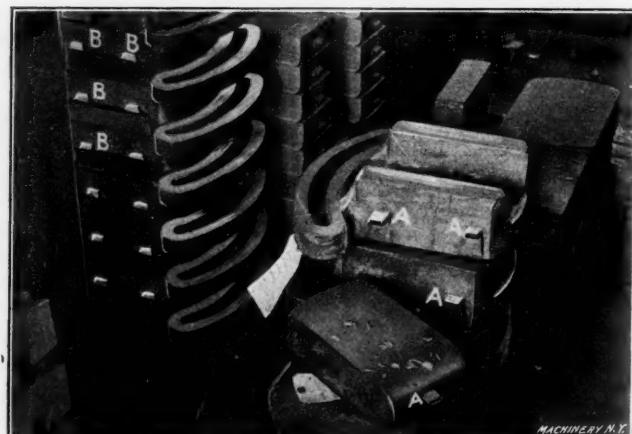


Fig. 14. Lugs on Castings for Convenience in Clamping



Fig. 15. Clamping Pieces on Planer by Means of Lugs

The use of small easily removed lugs on castings for the purpose of clamping while machining, is a feature that is not employed in other shops to the extent it should be. In numerous cases, this would save jigging or several settings. Fig. 14 shows several clapper boxes and blocks, planing lugs being

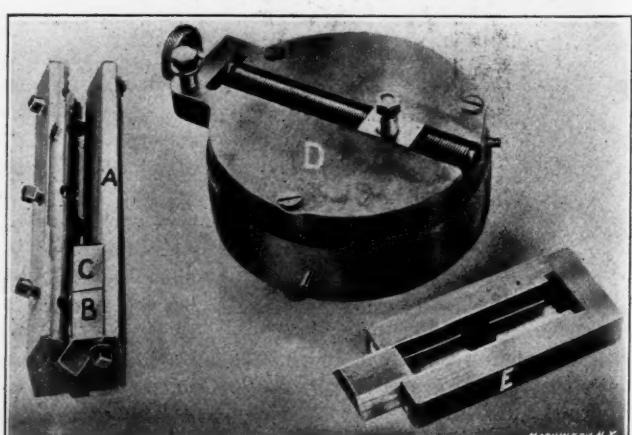


Fig. 16. Friction Blocks and Planing Jig

shown at A, while at B they have been knocked off after the parts were finished. Fig. 15 shows how these lugs are made use of in clamping down long and comparatively thin castings.

Small dovetail blocks used in planer frictions are planed in the jig A Fig. 16, two of the blocks being shown at B and

*C.* These blocks are cast approximately to shape, planed top and bottom and then placed in this jig where the bevels on both sides are planed. At *D* is shown one form of friction block in which these blocks are used, and another is shown

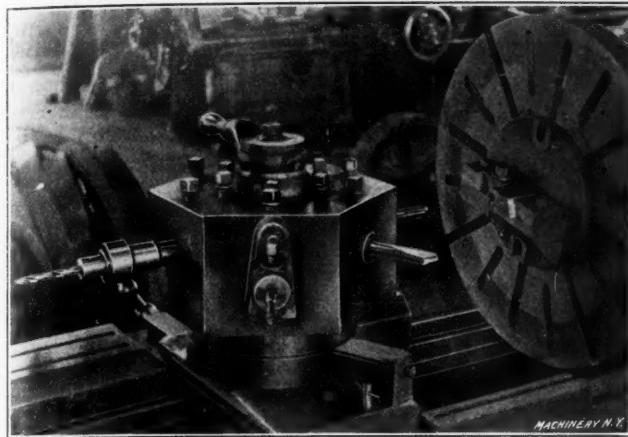


Fig. 17. Screw Machine Chuck and Tools for Friction Slides

at *E*. After planing, the blocks are drilled, bored, countersunk and tapped in a screw machine as shown in Fig. 17.

#### Balancing Pulleys

While pulleys of various kinds and sizes are turned as far as possible on the inside of the rim as shown at *A*, Fig. 18, yet in order to run well they must be counterbalanced. The standing balance is obtained by using the Bowsher balancing

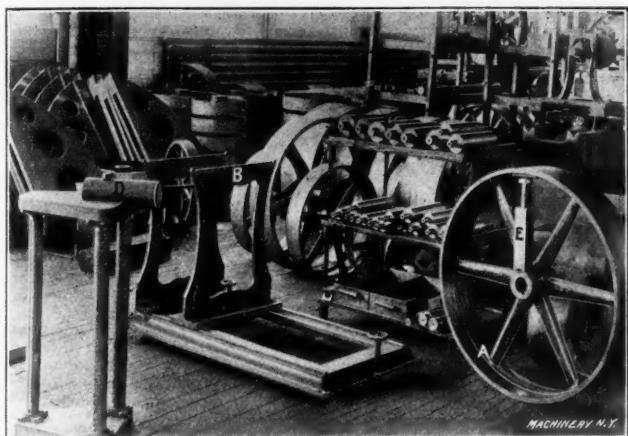


Fig. 18. Pulley Balancing Tools

ways *B* and riveting on pieces of iron where indicated. Specially ground mandrels on which to mount the pulleys are shown at *C* and a riveting stand for small pulleys at *D*; large pulleys, however, have counterweights riveted on by using the backing block shown at *E*, which consists of a post to brace against the hub and a heavy screw with a hardened head, slightly countersunk in the middle for the rivet head.

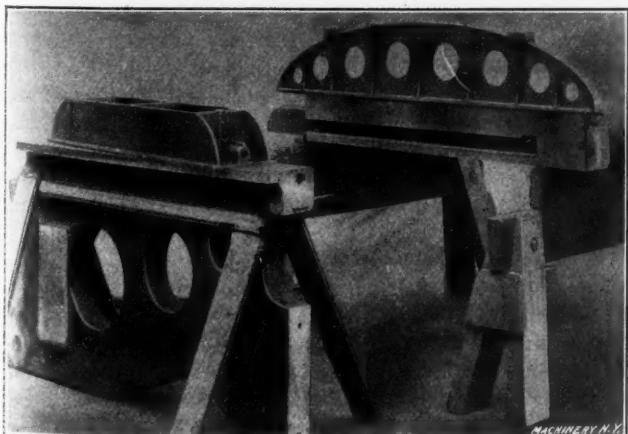


Fig. 19. Scraping Plate and Straightedge

Fig. 19 shows a master plate and a straightedge to which the housings and other parts are scraped.

#### Reservoir for Oil from Planer Ways

Oil from planer ways is collected, strained and used again

as shown in Fig. 20. The plan pursued on old planers is to cut a hole near the ends of the V's as at *A*; from the bottom of these, tubes *B* are run to a small tank *C*, which has a screen in it to retain the dirt, the oil being drained through the stop cock *D* into the pan *E*, after which it is poured back into the oil pockets which are of the usual roller oiling type.

#### A Numbering Jig

Numbers are stamped evenly on crossrails by using the jig shown in Fig. 21, which has a thumb-screw on the back

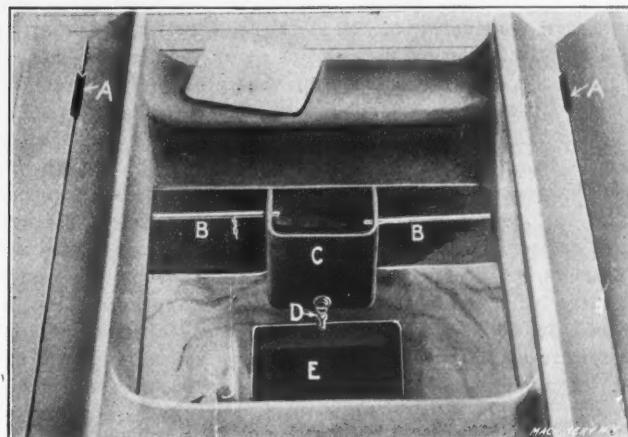


Fig. 20. Device for Saving Oil from Planer

to hold it securely in place. The numbers used have the sides ground so as to make a snug fit in the spaces for five figures and a large space for the "No." stamp.

#### ANNUNCIATOR FOR GEAR-CUTTERS

An electric annunciator is employed in the gear-cutting department of the King Machine Tool Co., Cincinnati, Ohio, to call the attention of the operator (who attends to several machines) when the gear blanks have been fully cut. The device for making electrical contact on the machines is simple, consisting of an arm attached to the index wheel, and a contact

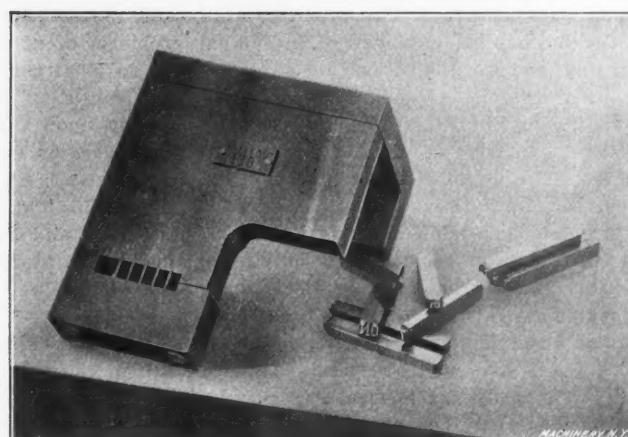


Fig. 21. Number Stamping Jig

finger mounted on the frame of the machine. This finger is engaged by the arm at one point in its revolution. The operator starts the machine cutting a blank with the arm standing just beyond the finger, and when it has turned all the way around contact is made. The annunciator rings and indicates the number of the machine requiring attention.

The device is so constructed that the electrical connection is maintained until the contact finger is straightened back into normal position; thus, should the operator neglect to attend to a machine on which the blank is finished, the annunciator will continue to ring until stopped by turning back the contact finger.

It is mentioned in the *Practical Engineer* that the Inner Farne Island has been provided with an automatic light-house, machinery having been installed which turns on the acetylene gas at dusk and turns it off at dawn. It is stated that the light-house will need attention only once every six months.

## THE MECHANICAL ENGINEER AND PREVENTION OF ACCIDENTS\*

The preservation of the lives and limbs of industrial workers is a more vital question than any other which the mechanical engineer meets in the industrial field. Accident clauses, wise and less wise, have been included in the laws of various states, but legal obligation to safeguard industrial workers has not alone succeeded in preventing avoidable accidents to any great extent. The subject of the prevention of accidents, however, is now coming to the front as a humanitarian consideration. It is the object of the author to initiate a discussion on the prevention of accidents by stating in detail the principles encountered as they have presented themselves to him.

In this matter the United States has lagged considerably behind Great Britain, Germany and France—which countries more than thirty years ago began to enforce, with excellent judgment, laws for safeguarding industrial workers. The statistics covering industrial accidents in the United States are incomplete, yet according to the Bureau of Labor, the yearly mortality from accidents, among adult wage-earners alone, is between 30,000 and 35,000. The non-fatal injuries inflicted are upward of two million a year. These are conservative figures for a single year, and when compared with the more thorough foreign accident records, it gives just cause to inquire why the United States should be so far behind in conserving the lives and health of the industrial workers; yet the figures given take no account of the accidents affecting women and children in the industries, so that the total would be much greater were these recorded.

### The Mechanical Engineer and Accidents

From a study of the conditions of safety under which European and American industries are carried on, the author has come to the conclusion that the safeguarding of industrial workers cannot be attained entirely by legislative acts. The principles of safeguarding the workers should be as much a part of the education of the engineer as should those of efficiency in other directions. Many engineers enter into responsible control of industries with little or no realization of the dangers involved. The scientific study and the solution by the mechanical engineer of individual problems of safeguarding, and the instructing of employees, will do more than all other agencies to bring about satisfactory results. The prevention of industrial accidents depends largely upon the intelligent interest of engineers engaged as managers or designers. The attitude of the executive in such matters is all-important, and determines the policy of the whole plant. By proper supervision and precautions in all plants, and by the cultivation of greater care on the part of the operators, probably at least one-third of the annual accidents could be prevented.

As an example, it may be mentioned that in one plant which had a yearly average of 200 accidents, the result of the attention given to preventive measures reduced the number of accidents for the last year to 64. By the steps taken, the earning opportunities of the employees were in no case reduced. Of the 64 accidents during the last year, not one was due to the negligence of the employer, and in but one case was an accident due to the negligence of a foreman. In 25 cases the accident was due solely to the negligence of the person injured, and in 38 cases the occurrence was accidental and non-preventable in the most literal sense. The latter accidents evidently represent the unavoidable trade risk of this particular plant; yet the actual risk before safeguarding the machinery and instructing the employees in a thorough manner was six times as great as this non-preventable risk. This experience has been repeated in many cases.

### The Causes of Accidents

In analyzing thousands of accidents with a view of devising remedies, the author found the following to be the chief causes: ignorance; carelessness; unsuitable clothing; inefficient lighting; dirty and obstructed work places; defects of

machinery and structures; and the absence of safeguards. In current popular comment on the wastefulness of life and limb in industries, little regard is paid to the causes underlying accidents, but well-considered action must be based solely on this. Steam generators and other vessels under pressure, electric apparatus, railroads and elevators as contributing factors to accidents, have been omitted from the present consideration, because engineers have given a great deal of attention to these already. It is significant that it is chiefly in cases where property, as well as persons, is liable to injury that preventive measures against accidents have as yet been generally and efficiently elaborated.

### Ignorance

In spite of ample facilities for the acquisition of some knowledge of mechanical principles, the author has found some superintendents, a number of foremen, many operators and not a few managing owners of smaller plants grossly ignorant of the possibilities for preventing accidents to themselves and others. Nothing but administrative vigilance in selecting employees and instructing them regarding their own special risks will prevent accidents due to ignorance.

### Carelessness

Carelessness, sometimes combined with ignorance, sometimes due to sheer thoughtlessness or folly, stands highest as a cause of industrial accidents. Little can be done to shield the worker and those whom he sometimes involves from the results of his own carelessness. It is the author's experience

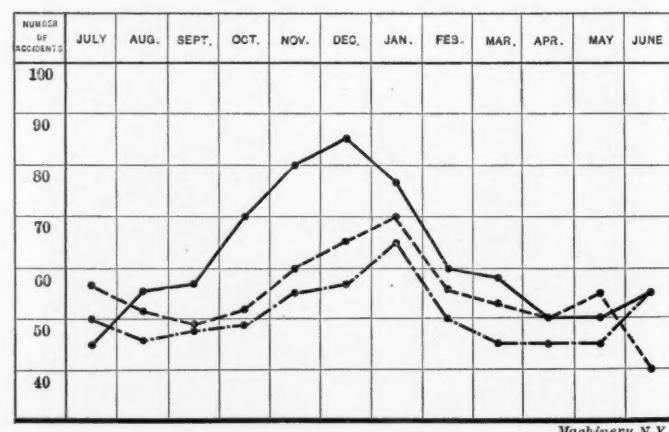


Fig. 1. Influence of Daylight on the Number of Accidents

that the bright and nervy American workman is usually the first in taking foolish and wholly unnecessary chances with his life and limbs—chances which in no way add to his efficiency or his earnings. The maintenance of strict discipline in the shops and the elimination of the dangerous employee is all that can be done in addition to a campaign of education throughout the shop.

### Unsuitable Clothing

Accidents are sometimes caused by many machine parts which are necessarily exposed near the operator and with which he would never come into dangerous contact except for the use of unsuitable clothing. Ragged sleeve ends, loose ties, and open jackets of untidy machinists have, again and again, been wound upon seemingly small parts in motion and inflicted frightful and sometimes fatal injuries. Not a few survivors have to thank the inferior strength of the usual overall for their escape.

### Inefficient Lighting

Inefficient lighting is the cause of numerous accidents. The author has observed that the maximum of accidents have occurred toward the close and beginning of each year, during the months of minimum daylight. The accompanying illustration Fig. 1 shows the seasonal distribution for three successive years of about 700 deaths annually, due to industrial accidents reported from 80,000 plants.

In shops, the intensity of artificial lighting at the cutting point of tools and over a limited area at the machine tool or bench is frequently far above actual requirements, while all around the operator a semi-darkness prevails which has a

\*Abstract of paper read by Mr. John Calder before the American Society of Mechanical Engineers, February 14, 1911.

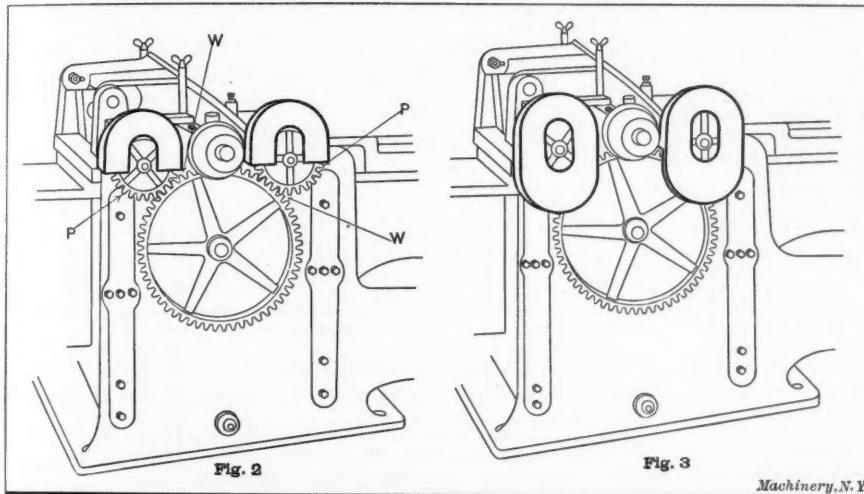
blinding effect, and is a source of danger. It has been found that the concentrated illumination, by means of shades, of ordinary 16-candlepower incandescent lamps at cutting tools in machines is often several times as intense as the ordinary daylight on the same parts. From the point of safety, the elimination of this excessive light on spots is required, and a more generally diffused light of less unit intensity should be substituted by the use of fewer but larger lamps, located to suit varying shop requirements, and reflecting from white walls and ceilings. The mechanical engineer, administering or designing plants, can do much to reduce the accident risk from this cause.

#### Dirty and Obstructed Work Places

Dirty and obstructed work places are closely allied to defective illumination. It is the duty of the management of every shop to see that the cleaning of floors and passages and the removal of waste are systematically provided for. Sometimes this condition is due to the employe himself; sometimes it is due to attempts to save floor space, thereby crowding machines and workers together without due regard to their safety. Almost all mechanical operations can be conducted

The machine tool builders have already accomplished a great deal in the way of useful safeguarding, particularly in guarding against the dangers of gears in metal-working machinery. Sometimes, however, so-called "guards" are encountered which are not guards at all but rather delusions, indicating that the designer had appearance rather than utility in mind. This is illustrated in Fig. 2, where the pinions *P* have been covered on the top, which is the out-running and safe side, by semicircular flanged hoods, whereas the intaking and dangerous parts of the gears at *W* are unprotected and likely to grip the clothes and fingers of unsuspecting operators. Fig. 3 shows the proper way to protect the gears in the machine illustrated.

Many designers seem to believe that anything which looks like a cover for a part of a machine constitutes an efficient safeguard, but this is not true if no regard is paid to the actual direction of rotation or to reversal of motion, or to the likelihood of the guard being left off permanently. The real points of danger in daily practice must be studied before a satisfactory protection can be provided. Shafts and spindles, low pulleys, belts, gears, narrow clearances between fixed and



Figs. 2 and 3. Incorrect and Correct Application of Gear Guards

under pleasanter and safer conditions than at present, as far as light and cleanliness are concerned.

#### Defects of Machinery and Structures

Apart from the question of specific safeguarding provisions, the author's experience points to the fact that machines or processes which are essentially dangerous because of defective design or arrangement, or from lack of repairs, are comparatively rare. It does not pay any employer to keep a defective tool in operation, nor is it in the interest of the employe to use imperfect apparatus. While defects of machinery contribute to some serious and a number of minor casualties, they do not do so to the extent commonly alleged.

#### Absence of Safeguards

Absence of safeguards, although it is not the most prolific cause of accidents, closely concerns the mechanical engineer. In the eyes of the public and the non-technical investigator, this matter is of the first importance. In many cases of injuries to operators caused by the absence of a suitable safeguard, it will be found that it has been removed or rendered ineffective by the employe. In many cases some machines will be safeguarded in one part of the plant and not in another, due to the operation of the principle that what is permitted to be everybody's business is nobody's business. The provisions for safeguarding should, therefore, never be left to the initiative of a number of individuals in any one plant.

The contributions of the mechanical engineer to the safeguarding of machinery fall into two divisions: 1. Efficient safeguard which he designs as parts of machine tools and apparatus. 2. Safeguards which he may devise and supply as the mechanical engineer of a plant using apparatus capable of inflicting injury if permitted to remain as installed, or which cannot be intelligently protected until all related apparatus is in position and the operating conditions of the employe fully apparent.

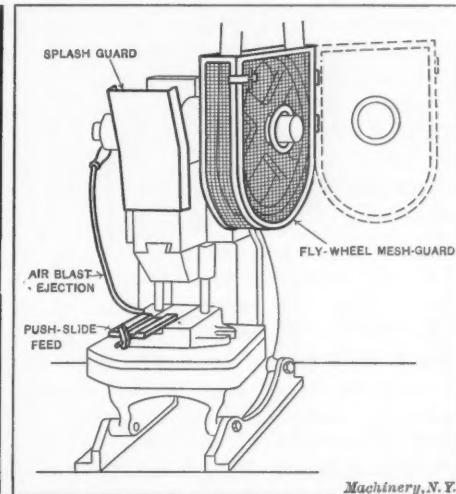


Fig. 4. Punch Press with Air Blast Ejector, Push-slide Feed and Flywheel Guard

moving parts, couplings, projecting screws, nuts and pins, etc., are all best protected by the machine tool builder when designing the machine. It is important that the guards for machines are so designed and applied that there be no temptation for the workman to throw them aside as cumbersome. To educate the employe to use caution and foresight about dangerous machines is difficult enough, and it should not be rendered more so by making him work with an impractical safeguard. A careful inquiry into the conditions under which an employe has to work should be made and the safety devices should enable him to work with the same efficiency as without the safeguard.

When guarding equipment built in position, the manner of installation and the precise nature of the workman's duty around it must be taken into consideration. Protection against accident in power-generating machinery, for instance, is not secured, as is sometimes supposed, by merely guarding the dangerous moving parts. In power houses, for example, the edges of all stairs, platforms, ladders and gratings should have low fenders of metal on all sides so as to prevent nuts, bolts, tools and other small parts from rolling off into the machinery or striking the employes. In addition, a double metal railing not less than three feet high and not nearer than twelve inches to any moving part, should be provided at all dangerous places, such as crank and flywheel pits, and at the inside and outside edges of all stairs and elevated platforms.

#### Punches and Presses

Punches and presses are causes of frequent accidents. The mechanical engineer cannot be too careful in seeing that these tools are in good repair, particularly as regards the actuating mechanism. Automatic roll feeds, sub-presses, magazines, hoppers, gravity slides, etc., have done a great deal to eliminate the danger of feeding such presses by hand. The increas-

ing use of compressed air in mechanical industries permits of light pieces being blown off the die at the end of the operation by a cam-operated blast properly directed and timed as indicated in Fig. 4. The ordinary spring ejector serves the same purpose for heavier work. In Fig. 4 a convenient flywheel guard is also illustrated. Provision is made by means of a door for the tool-setter to move the flywheel by hand without detaching the guard. The work in this machine is fed in by a push-slide so that the operator does not have to place his fingers under the punch at all. In Figs. 5 and 6 are shown two forms of guards, consisting in the one case of a screen, and in the other of a bar, which are timed to descend on the operator's fingers, if these be in a position of danger, and force their withdrawal before an accident occurs through the descending punch.

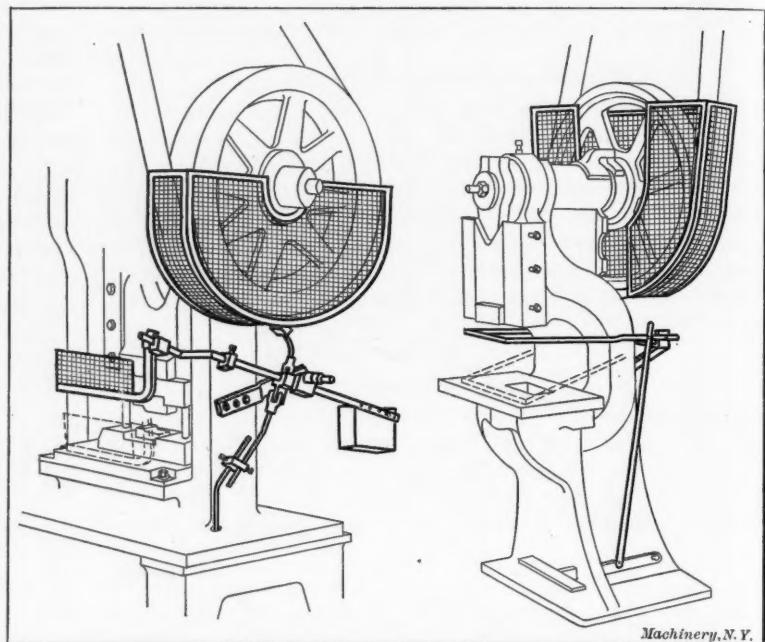
#### Grinding Wheels

Various methods are employed for confining bursting wheel fragments to a guard-casing or for rendering their velocity harmless. Figs. 7 and 8, show various forms of guards or armors, successfully used for retaining fractured wheels on grinders. The guard in Fig. 8 has hinged sides of plate steel and a strong cast-steel front guard, also hinged. The guard as a whole can slide parallel to the plane of the wheel for taking care of reduced wheel diameters. The hinged front guard can be dropped to meet the same condition. Wheels have been tested to destruction with both of the guards shown, without wheel fragments being thrown around.

#### Conclusion

In all industries the executive should reckon closely with the varying degree of responsibility which can be expected of young persons, men and women, respectively; no person under 16 years of age should be employed at or near machinery, and no one should be allowed to clean machinery while it is in motion. The installation of machinery in relation to walls, passages and adjacent tools and equipment should be given careful consideration. In any confined space through which any person is likely to pass and toward which the carriage of any self-acting, reciprocating machine runs out, there should be left a clear passageway of 18 inches between the extreme outward position of the carriage and the wall.

In conclusion, it should be said that safeguards should be constructed of metal to secure durability. Reinforced steel

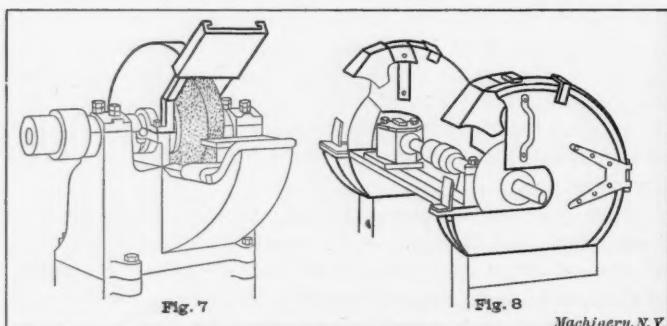


Figs. 5 and 6. Punch Presses with Effective Safety Devices

attention to systematic trials. Attempts were made to obtain audible signals, but in general it was not thought advisable to have the signals act as automatic stops. Some of the first experiments were made with sirens and horns set up at the side of the track and electrically operated. When the train gets within 1200 feet of the distant signal, it causes the horn to sound if the signal itself is standing at "caution," and the sound continues to be heard until the head of the train has passed 160 feet beyond the distant signal. These experiments are not yet concluded. One of the difficulties met with is that with some express trains the sound of the horn is not loud enough to attract the attention of the engineer.

On other roads experiments were made with an electric apparatus, using a brush contact. On approaching a distant signal the arrangement caused a visual signal in the form of a disk to appear in the cab. The results of these experiments were not satisfactory for the reason that the contact brushes were repeatedly damaged by the ballast or the other objects on the track, and sometimes at high speed the appliance failed to act. In another device so-called "slippers" were used on the locomotive, sliding on raised treads, the lifting of the slipper causing a depression of a rod on the engine. This apparatus was designed as an automatic stop, but the connection to the brakes has been cut out, and it is used merely as a signalling apparatus. During snow storms, however, this device caused trouble because the treads could not be moved into position and the signals became uncertain.

Other experiments were undertaken with a wireless apparatus by means of which signals were sent to a receiver placed on the locomotive from a sending station, the signals produced consisting of colored disks in the cab. Difficulties with this apparatus were met with on account of the fact that telegraph lines crossing the track, etc., would produce the same effects as the wireless wave from the sending station. Perhaps the best results have been obtained with a recording alarm, so operated that a bell will ring in the cab when a signal is overrun; to stop the bell from ringing the engineer must record the overrunning. This apparatus has been tried by five different divisions with good results. Absolute reliability has, however, as yet not been obtained with any apparatus, and the experiments will be continued and extended.



Figs. 7 and 8. Effective Guards for Grinding Wheels

mesh work is preferable for all but the heaviest machinery, because it permits of easy inspection without detaching the safeguard. Warning and caution notices should be sparingly used and as brief as possible. They give possible legal protection against damage suits, but are practically worthless if no attempt is made to enforce them. Every executive and engineer will find it a valuable adjunct to the safety engineering of the plant to maintain in every department a record of every accident and also every "near" accident. An examination of these records without regard to legal compulsion will help more than anything else to remove speedily the causes of accidents and the present great reproach against our industries.

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It is a great deal easier to point out the shortcomings of the boss than it is to fill his boots from day to day.

### A METER FOR RECORDING THE FLOW OF GASES

The accurate measuring of the flow of gases passing through a pipe line is a matter of considerable difficulty, particularly when the pressure and temperature of the flowing gas varies from time to time, and the measuring instruments are required, nevertheless, to record the quantity of gas reduced to a standard pressure and temperature. For this reason the meter illustrated and described in the following will prove of especial interest. This device, known as the Thomas meter, is made by the Cutler-Hammer Mfg. Co., Milwaukee, Wis., and serves the purpose of graphically recording the quantity of flow of gases at any pressure and at any temperature, independent of the fluctuations of pressure or temperature to which the flowing gas may be subjected. The design of the meter is based upon a scientific principle ingeniously applied, and is, therefore, of more than ordinary mechanical interest.

#### General Design of Meter

A diagrammatical view of the meter is shown in Fig. 1. It consists of an electric heater *B* made of suitable resistance material, and placed across the passage of the gas in such a way as to heat all the gas passing through the pipe line of which the meter forms a part. The object of the heater is to

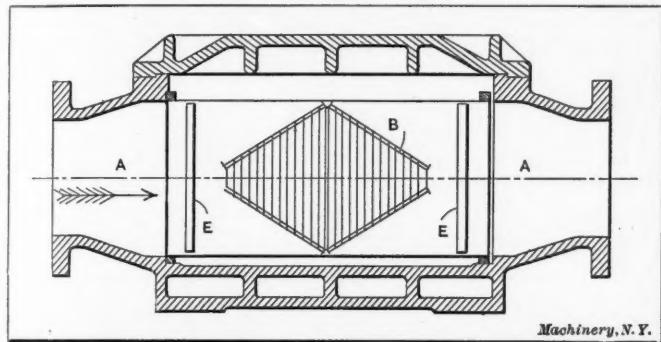


Fig. 1. Diagrammatical View of the Thomas Meter for Recording the Quantity of Flow of Gases

raise the temperature of the gas to a higher exit temperature than that at the entrance. The temperature at either side of the heater is measured by the two electrical resistance thermometers *E*, acting in connection with an automatic regulating mechanism, as will be further explained later. The thermometers consist of screens made of nickel wire, which like

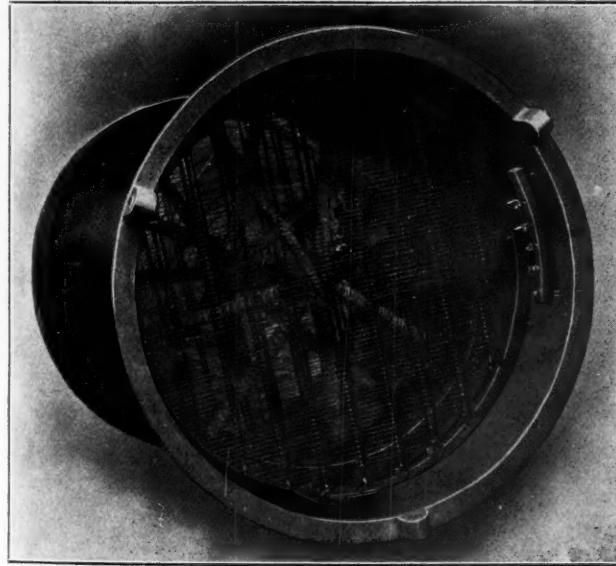


Fig. 2. Meter Casing through which the Gas flows, showing the Resistance Thermometer and the Electrical Heater

many other materials changes its electrical resistance in direct proportion to the changes in temperature. This simple arrangement, properly connected and controlled, makes it possible to obtain a record of the gas flow, and to read it off directly on the dials of an integrating watt-meter or by means of the curve drawn by a recording watt-meter.

The actual appearance of the various parts of the meter is shown in the halftone illustrations. In Fig. 2 is shown the meter casing through which the gas flows; in Fig. 3, the electrical resistance forming the heater of the meter; in Fig.

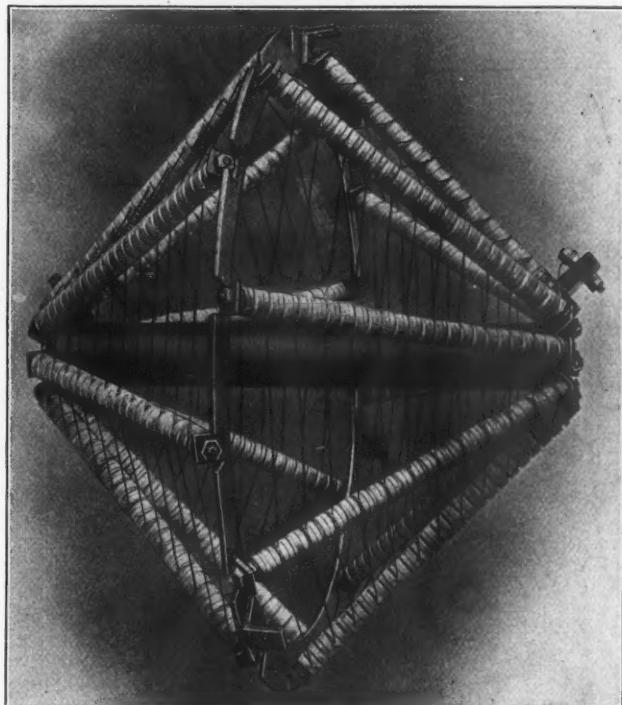


Fig. 3. Electrical Resistance forming the Heater of the Meter. By Means of this Device the Temperature of the Gas is raised Two Degrees as it flows through the Meter

4, the screen of nickel wire which acts as a thermometer, and in Fig. 5, the switchboard and recording instruments of the meter.

#### Principle of Action of Meter

Suppose that gas or air flows at a uniform rate through a pipe *A* shown in Fig. 1, and that it passes on its way an electrical heater *B*. Suppose also that the heater gives off

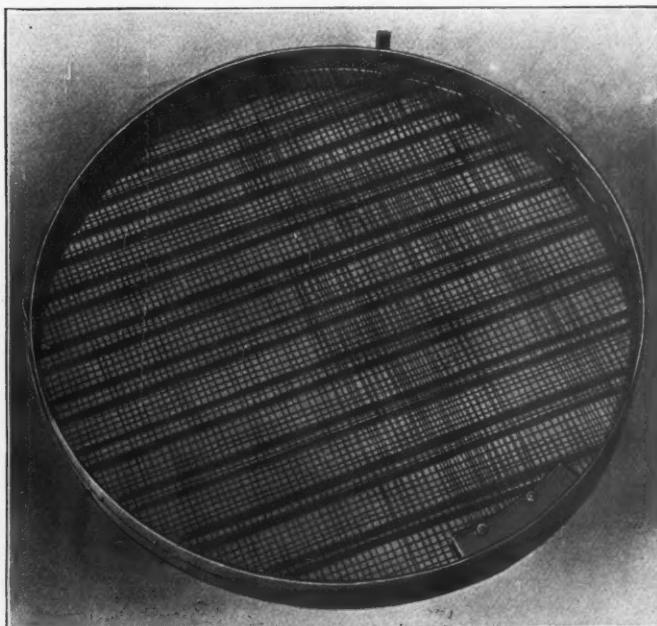


Fig. 4. Screen of Nickel Wire which acts as a Thermometer in the Thomas Meter

heat at a standard rate, which would be the case if the voltage across the heater terminals remained constant and if the resistance of the heater did not change. It is then evident that if the flow of gas and the liberation of heat are both uniform and constant, the temperature of the gas will be raised a certain number of degrees as it passes through the heater; and this temperature rise will remain constant so long as the conditions specified do not change.

If now the rate of flow of gas is increased, but the rate of heat liberation remains constant then the temperature of the

greater amount of gas flowing through the meter cannot be raised as many degrees as the temperature of the smaller amount of gas, and the temperature difference between the entrance and exit of the meter will, therefore, be smaller. On the other hand, if the amount of gas decreases, the tem-

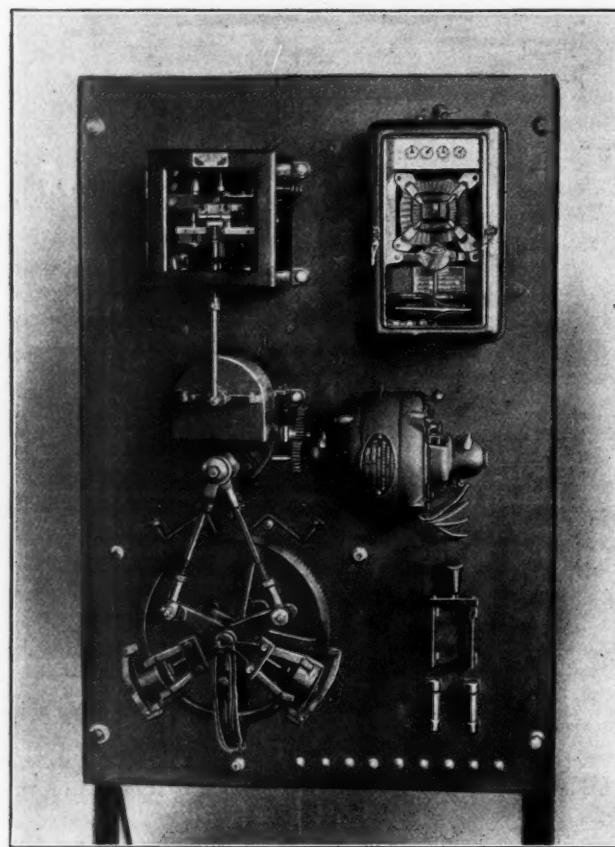


Fig. 5 Switchboard and Recording Instruments of the Meter

perature difference will increase. Hence, the temperature difference is an index of the rate of flow of gas so long as the rate of heat liberation is kept constant.

This principle was applied to the Thomas meter during its development, but while excellent for laboratory purposes, it was found to be impractical in the case of meters for commercial service, because a constant voltage can almost never be obtained. Hence the application of the principle outlined above is modified for the commercial meter. Instead of measuring a varying temperature difference, the temperature difference is kept constant, and the number of watts required to maintain this constant difference in temperature between inlet and outlet will vary directly as the quantity of the flow of gas or air. Hence, the amount of gas passing through the meter can be directly recorded by a watt-meter.

The difference in temperature between the inlet and outlet of the meter is 2 degrees F. This difference is maintained by the action of the nickel-wire screen resistance thermometers *E* in Fig. 1, by means of which the resistance in the electrical heater is controlled in a manner which will be described in detail later. As soon as the difference in resistance in the thermometers becomes greater or less than that corresponding to the desired 2 degrees temperature difference, the controller causes a small rheostat to operate, thereby restoring the balance between the thermometer resistances, this balance being attained only when the temperature difference given becomes 2 degrees. Thus, if the rate of flow of gas is increased, the temperature difference tends to decrease, and at once addi-

tional energy is introduced sufficient to heat the increased weight of gas, and vice versa.

It is apparent from what has been said that the accuracy of these meters is not affected by changes in the pressures of gas or air flowing through the pipe line, because the unit of measurement is that of weight rather than of volume. Neither does a variation of temperature of the incoming gas affect the accuracy of the meter, because it is a difference of temperature rather than a fixed temperature upon which the action of the meter depends. The possibility of measuring gas or air accurately irrespective of its pressure or temperature is the most interesting fact in connection with this device; and the meter can be used for gas or air at either high or low pressure and at either high or low temperature; and fluctuations of either will not affect the final reading of the instrument, which can be arranged to record the flow of air or gas at any desired standard of pressure and temperature. The determining factor, of course, is simply the specific heat of the gas, the flow of which is measured.

The apparatus is applicable to the measurement of gas or air, whether dry, saturated, or superheated. If water is carried along mechanically in the form of a fog or mist, this can readily be transformed into vapor by the introduction of heat from a small steam radiator, consisting of a coil of pipe, placed at the entrance to the meter. When water vapor is contained in the air a correction is required, owing to the fact that the specific heat of water vapor is twice that of air. This correction ordinarily, however, amounts to only about one-half of one per cent.

The specific heat of any given kind of gas appears to be nearly constant even when there are minor changes in the composition of the gas, because the constituents which vary from time to time are not those which have the greatest influence in affecting the specific heat.

#### Switchboard and Apparatus Used for Recording the Flow of Gases

The switchboard on which the instruments are mounted which make possible the measuring of the flow of gases by the method outlined, is shown in Fig. 5. A diagrammatical view of the heater, switchboard, recording instruments and connections is shown in Fig. 6. In the latter illustration the controller *G* is a galvanometer and Wheatstone bridge com-

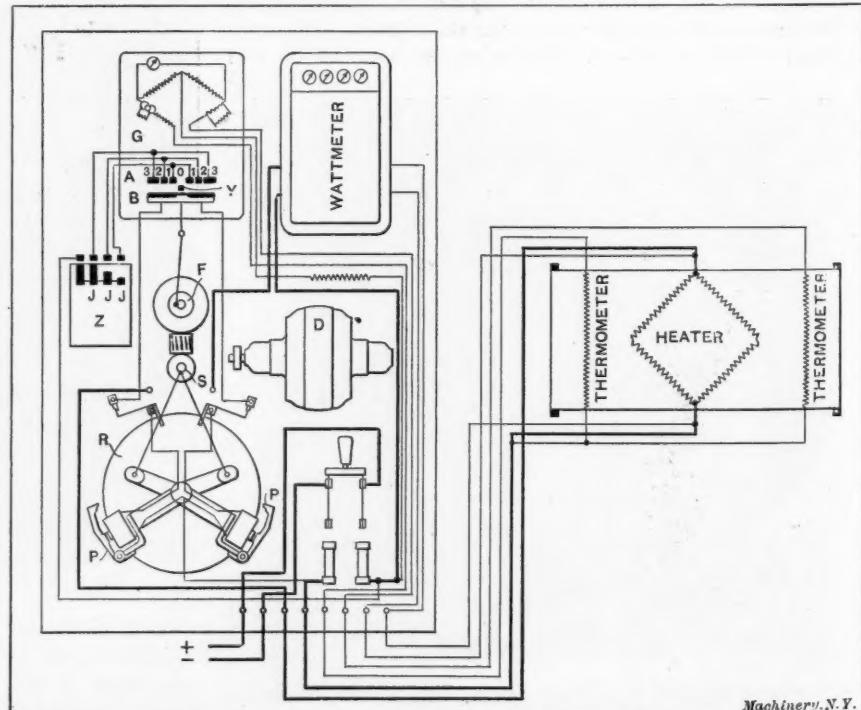


Fig. 6. Diagrammatical View of Heater, Switchboard, Recording Instruments and Connections

bined. The movable needle *Y* swings to the left or right of the zero position according as the difference in resistance of the thermometers is greater or less than that corresponding to the required temperature difference of 2 degrees between the inlet and outlet of the meter. A motor *D* of  $\frac{1}{8}$  horsepower

operates continuously, and by means of a crank *F* causes the bar *B* to move up and down, clamping the needle *Y* at the top of the stroke against the contacts *A*. The motor also drives at a slow but constant speed the contact drum *Z* and two eccentrics *S* which give to the rheostat pawls *P* a reciprocating vertical motion through small arcs along the edge of a ratchet wheel *R* on the rheostat shaft. On the drum *Z* are placed three segments *J* of different lengths corresponding to one, two or three teeth on the wheel *R*. If needle *Y* is clamped in position 1 at the right of the zero position, the pawl is engaged at such a time in its stroke as to increase the heater energy by one step of the rheostat. If *Y* is clamped in position 1 to the left of the zero position, the heater energy is decreased by one step. If it is clamped in position 2 to the right or left of the zero position, the heater energy is increased or decreased by two steps, etc. In any case *Y* is returned to the zero position, and the change in the heater energy is continued until it has come back to this point. When *Y* is at zero, no change takes place in the rheostat.

The watt meter in the upper right-hand corner of the switchboard shows the energy required to maintain the constant difference of temperature, and the dials are so graduated as to register the total cubic feet of gas or air passing through the meter at a standard pressure and temperature. The switchboard and recording mechanism can be placed in

## NEW PLANT OF THE KEMPSMITH MFG. CO.

The Kempsmith Mfg. Co., Milwaukee, Wis., manufactures milling machines exclusively, and consequently a specialization of system and equipment has been employed throughout the entire plant, which would not be used in a general manufacturing concern. Problems peculiar to the needs of milling machine manufacturers had also to be solved.

### General Layout of the Buildings

The buildings consist of the main factory, the power plant, pattern shop and office, as shown in Figs. 1 and 2. The factory proper is of the modern structural steel saw-tooth roof construction, with concrete floor and roof. It is a single room, 300 feet long by 250 feet wide. The pattern shop is 90 by 50 feet, and the power plant 100 by 50 feet. These buildings are of the modern girder steel type construction, and have concrete floors and roofs. All the factory buildings are absolutely fireproof. The office, as shown in Fig. 1, is in a separate building, and is of modern design and fully equipped.

The general layout was planned for convenience, a minimum amount of moving of the parts being necessary in the process of manufacture. The arrangement in the factory is such that these parts in their travel from one machine to another, make an automatic circuit of the shop from the

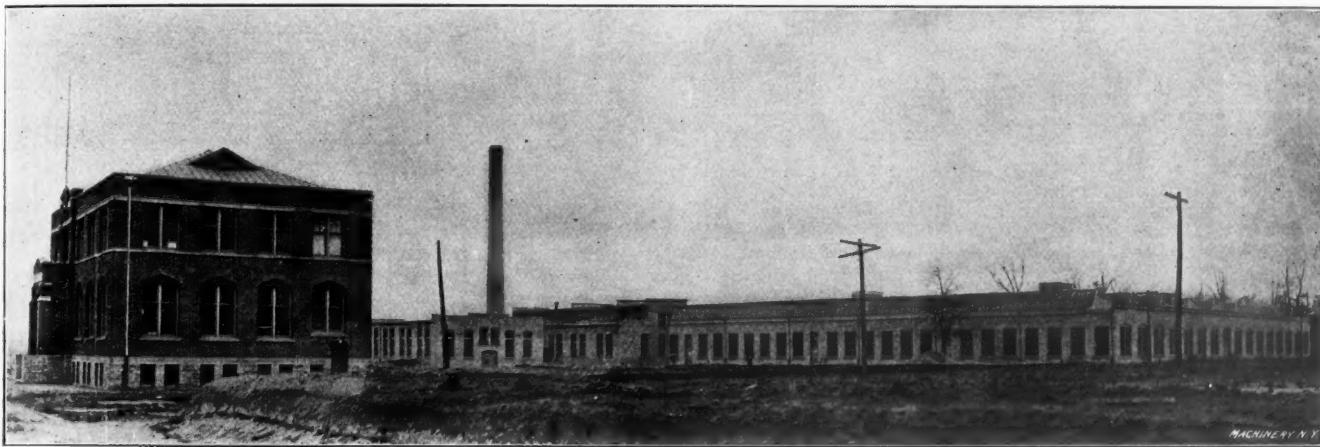


Fig. 1. General View of the Kempsmith Mfg. Co.'s New Plant

any convenient position as, for instance, in the office, thus permitting a constant observation of the flow through the pipe line.

### Theoretical Basis of the Meter

As 3412 British thermal units are equivalent to one kilowatt-hour, it is a comparatively easy matter to give an equation showing the relation between the amount of gas passing through the meter and the electrical energy required to heat it 2 degrees F.

Let *G* = cubic feet of gas per hour,

*S* = specific heat per cubic foot,

*T* = temperature difference in degrees F.,

*E* = energy in kilowatts.

Then  $G \times S \times T =$  the number of thermal units required. Or expressed in a different way

$$GST = 3412 E$$

from which

$$\frac{GT}{E} = \frac{3412}{S} = K,$$

*K* being a constant dependent upon the specific heat of the gas. Since in this meter the temperature difference *T* is kept

constant, it follows that  $\frac{K}{T}$  is constant. Let  $\frac{K}{T} = C$ .

Then

$$G = \frac{KE}{T} = CE$$

Thus it is evident that the relation between the number of cubic feet of gas per hour and the energy in kilowatts is directly dependent upon the specific heat of the gas, which can be determined from the customary chemical analysis and the specific heat of the constituents of the gas; and a final record can be obtained directly in cubic feet, as stated.

machining department to the assembling, testing and shipping departments. The factory is under a double system of supervision. One superintendent looks after the manufacturing of the small parts, while the other looks after the large castings, assembling, testing and shipping departments. The machines are arranged in groups, all machines of one type being in a single group, driven by one motor. The motors are hung from the steel-roof trusses on frames made from I-beams which are fastened with U-bolts. This allows the shifting of the motors when necessary, and at the same time permits the mounting of the motors without cutting the steel work. The lineshafting is in no case very long, and because of the fact that in specialized manufacturing of this kind, machines can be in most cases in operation 75 per cent of the time, the group drive system is more economical than the individual motor drive. Only where machines are in intermittent and irregular service is the individual motor employed.

A rather unique feature in connection with the lineshafting, is the brackets that are employed to lower the shafting about three feet below the main beams. Bolting the bearing bracket on the horizontal members of the roof trusses would bring the shafting so high that the belts would be too long. Steel brackets built up of channel-and-angle sections are used to support the bearings, as shown in Fig. 7. Hyatt roller bearings are used throughout.

Milling machine castings as a rule are not very large, and it was proved that the single-trolley system with an electric hoist would handle the machines equally as well as the large traveling crane, which would be much more expensive both in first cost and maintenance. By referring to the illustration Fig. 2, it will be seen that the trolley systems are so planned that the work can be moved from one part of the factory to the other in a few minutes. This

feature is proving to be very successful. Electric hoists with a controlling device will elevate the largest machine with all its equipment fully boxed for export, and move it at a rate of five feet per second. A switching device is used to transfer the trolley with its load from one beam to another. The lathes, grinding, milling, and automatic machines, etc., are not used to machine the large castings, so do not

castings are unloaded from cars directly into the store-room, while the complete machines are removed to the finishing and polishing rooms, and from these to the shipping department. The finishing and polishing rooms are completely enclosed to keep the dust out of the remainder of the factory.

The tool-room, which is shown in Fig. 3, is centrally lo-

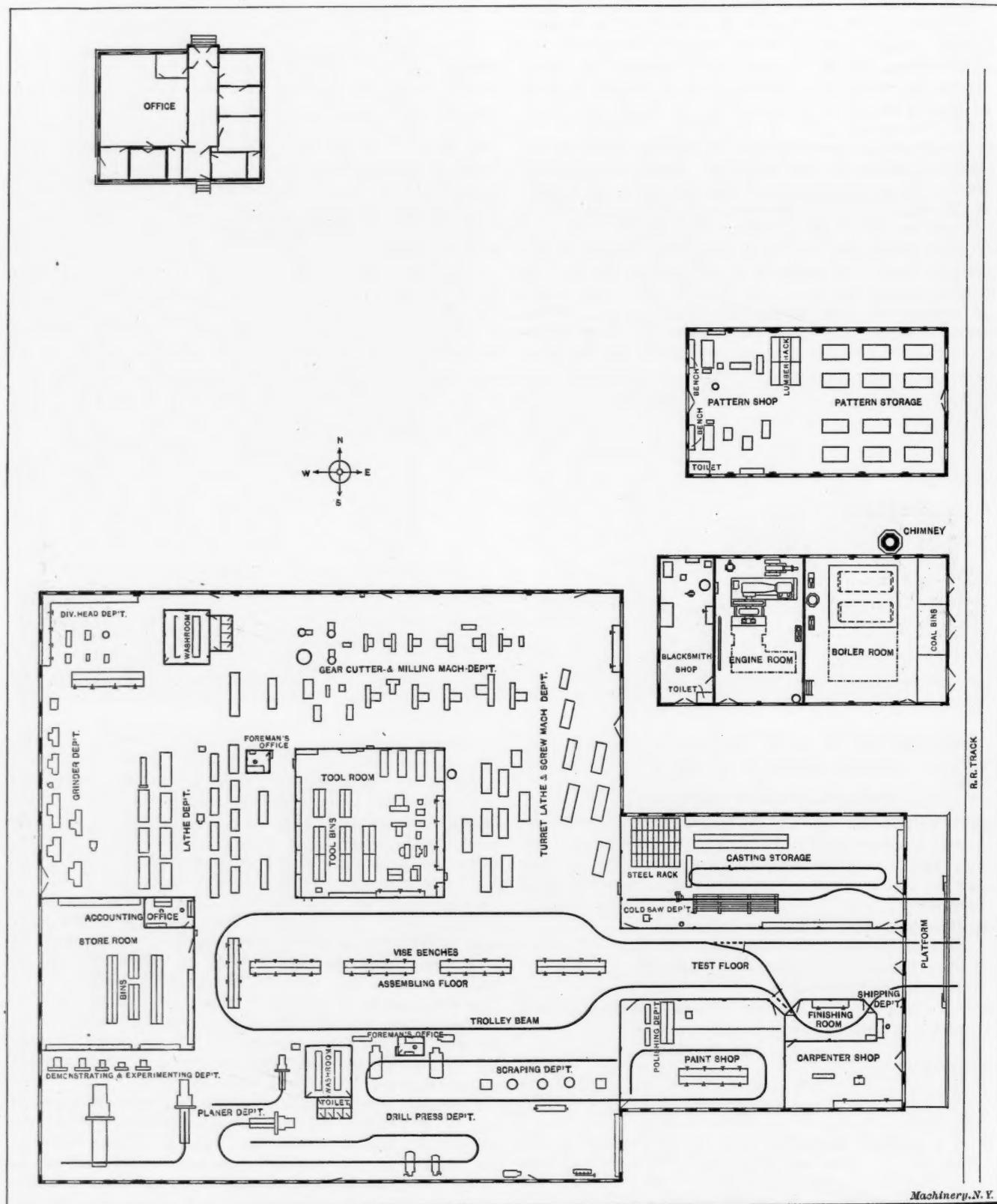


Fig. 2. Illustration showing the General Layout of the Plant

\* require a trolley system to transfer parts in process of manufacture.

The section of the main factory to the right, and nearest to the railroad track (see Fig. 2), is used for receiving and shipping. The trolleys which run directly over the railroad tracks give excellent facilities for unloading and loading cars. The rough-casting store-room, finishing and polishing rooms are also located in this part of the building. The

cated between the manufacturing and assembling departments. There is a delivery window on each side, and the equipment is so planned that it does not cause any delay in getting the tools. The stock-room, shown in Fig. 4, is also conveniently located and is equipped with steel bins to allow the storage of machine parts completely finished, but awaiting assembling, which may in some cases take place several months later. It is here that the cost account-

ant, time-keeper and stock-keeper have their office. A complete record is kept of each part and operation, no matter how small.

The assembling floor, a view of which is shown in Fig. 5, is located between the large and small manufacturing departments. A row of benches extending along the center allows the assembling of machines on both sides. The trolley system makes a complete circuit of these assembling benches, and is in constant service in shifting the machines that are being assembled.

The foreman's offices are completely enclosed with glass and are elevated above the floor about a foot, which gives the foreman a complete survey of his department at a

glance, without moving from his desk. He is not disturbed by the noise of the machines and small unimportant matters.

In the southwest corner of the building provision is made for a row of Kempsmith individual motor-driven milling machines. These machines are to be used for demonstrating and experimental purposes. The equipment of this department will include a complete set of electrical instruments and automatic recording devices.

The office is a modern two-story building, finished in quartered oak. The first floor contains the general office, and private offices of the general manager, purchasing agent and sales manager. The second floor contains the drafting room and the offices of the engineering department. The basement is equipped for the convenience of the employees, and has a dining room, kitchen, laboratory and a school-room. In the school-room the apprentices have a weekly class under the supervision of an instructor from the Wisconsin University, who gives them personal attention. This

#### Equipment

The boiler equipment consists of two 100 horsepower horizontal return-tubular boilers, made by the Milwaukee Boiler Co. The usual water columns, feed and blow-off connections, gages, injectors and safety valves are provided. A steam flue cleaner is also attached. The boiler feed-water pump delivers from a 200-horsepower Cookson open feed-water heater

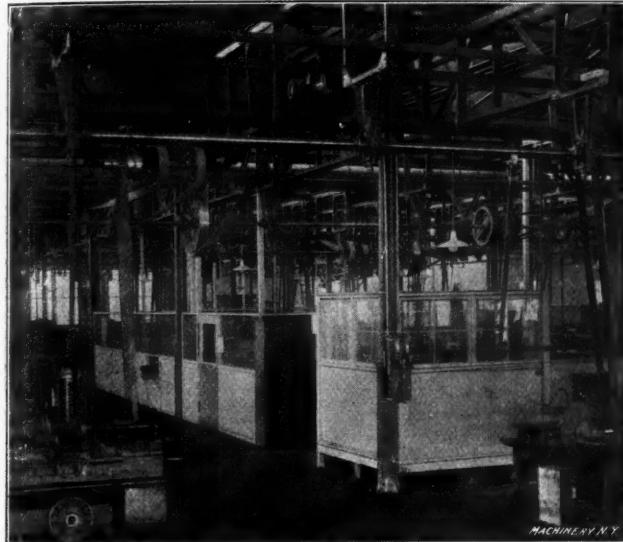


Fig. 3. View showing Foremen's Office in Foreground, and Tool-room in Background



Fig. 4. View showing Rough-casting Store-room to Left, Finishing Room to Right and Inspecting Floor in Center

glance, without moving from his desk. He is not disturbed by the noise of the machines and small unimportant matters.

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to the boiler. The feed-water heater, boiler feed pump and the vacuum pump are located in a space back of the boilers, ample room being provided.

The Webster system of heating is installed, the exhaust line from the engine being provided with an automatic back pressure valve, but live steam may also be used if



Fig. 5. Assembling Floor and Benches, showing Overhead Trolleys

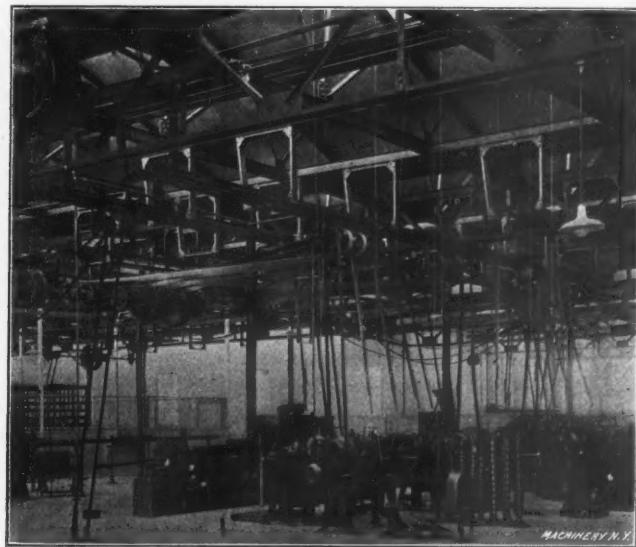


Fig. 6. Turret Lathe Department, showing Motor Group Drive

required, this being automatically arranged for, through the pressure reducing valve. Thirteen thousand one hundred feet of pipe coil and cast-iron radiation is used. Steam is delivered from the boilers at 125 pounds pressure through extra heavy wrought-iron piping to the engine room.

The electric generating equipment consists of one 14 by 30-inch, 200-horsepower, 120-R. P. M. Vilter rolling-mill type Corliss engine, direct connected to one 150-K. W. 250-volt, compound wound, continuous current Crocker Wheeler generator. An automatic oiling system is provided. The engine is operated non-condensing, as exhaust steam is used for heating.

The switchboard consists of six panels of two-inch dull black

finished slate, mounted on pipe frame work of latest design, and is very handsome in appearance with its dull black instruments and polished copper switches. It comprises one generator panel, one spare generator panel, one balancer panel, one four circuit power feeder panel, two four circuit lighting feeder panels and one swinging voltmeter bracket.

All wiring between the generator and switchboard, and from the switchboard to the machine shop, pattern shop and office, is under ground, and is enclosed in a conduit system constructed of bituminized fiber, laid in concrete. All cables in the conduits are insulated with 30 per cent para-rubber compound, are lead sheathed, and consist of two or three conductors as required.

The motors are of the Crocker Wheeler and Allis-Chalmers makes, and are all shunt wound, with the exception of those operating the planers, which are heavily compounded. Liberal belt centers are provided allowing good belt contact and consequent cool operation of motor bearings. Allen-Bradley Co.'s motor starters are used throughout, and are mounted for

## A HOBBY—THE HUMAN SAFETY VALVE

By S. R.

The writer is employed in a large factory in a small village. Each year, in answer to advertisements for help, men from all over the country come to this factory to work. A few of these men will stay permanently, but many leave before long. The reason why they leave seems to the writer to be the lack of a "hobby." Every man, especially the man who works mainly with his hands, needs a hobby, and if the writer were consulted in the preparation of a dictionary, he would insist that the word "hobby" be defined as "the human safety valve."

It is generally conceded that from all points of view the most desirable place for a wage earner is a first-class shop in a small town. In the first place, this shop being located away from the source of labor supply, is likely to have a management which is much more inclined to a liberal policy, and which makes it a point to keep the men in times of business

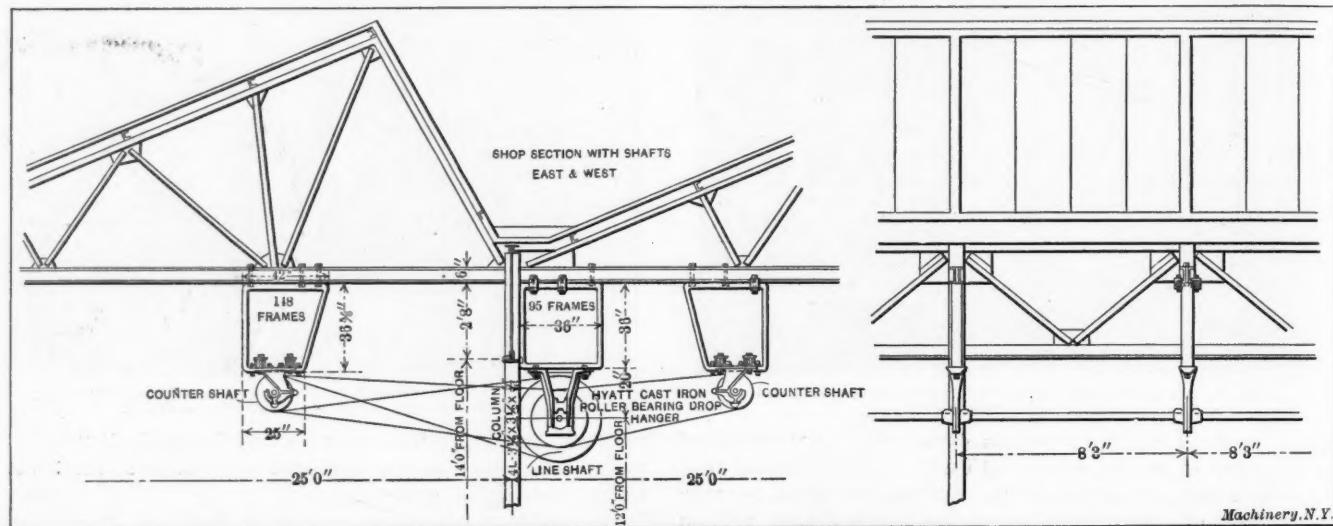


Fig. 7. Showing Location of Shaft Hangers and Roof Structure

each motor on a slate panel, which also contains an I. T. E. double-arm circuit breaker.

The illumination of the machine shop, pattern shop and power house, was carefully planned and every consideration given to modern illumination engineering principles. Uniformity and economy were the prime objects desired, and they were accomplished by the installation of a unit system consisting of a shock absorber, conduit stem, Benjamin steel porcelain enameled reflector, and a 150-watt, frosted-bowl, tungsten *Mazda* lamp. These units were hung 25 feet apart, and 10 feet above the floor, the plane of illumination being 4 feet above the floor.

\* \* \*

The melting of metals in vacuum is the ideal method, because oxidation is prevented and gases present in the metal are expelled from it. While it has long been known that the method of melting metals in a vacuum gave superior results in the final product, the method has been limited to very small quantities of metal due to the difficulty of carrying it out in practice. Metals which ordinarily are considered as brittle substances, and incapable of being rolled or drawn, can be produced, by melting them in vacuum, in a malleable or ductile condition. Examples of such metals are tungsten and tantalum, which in this way can be made in the form of wire, and are used to a great extent in the newly bought incandescent electric metallic filament lamps.

\* \* \*

In the article on the Selden patent decision, in the February number, it was stated that the Association of Licensed Automobile Manufacturers has announced that the case would be taken to the United States Supreme Court for final decision. It appears that this was erroneous, as later reports state that it has been decided not to take this step.

depression, rather than to go to the trouble of training a new set of men when work again becomes plentiful. In such a shop there is not as a rule, the hustle and rush that is found in the factories of a great city. In addition, rent is cheaper, food products are cheaper, and there are less chances to spend money. In short, living is cheaper. But, alas, the small town lacks opportunities for recreation, amusement and excitement, and this is where the trouble lies. That is why so many leave to return to their moving picture shows and fifty cent table d'hôte dinners. This they call relaxation; they cannot stand the simple life.

The trouble is that they have nothing with which to occupy their minds. Time hangs heavy on their hands; in a word, they do not have a hobby. Why is it, however, that a man is willing to give years of time to learn a trade, yet is unwilling to avail himself of the opportunities to gather information that most surely will some time be of very great value to him? The old saying that "A little knowledge is a dangerous thing" is very much out of date; the fact is "Every little helps."

One need not have a college degree nor even anything more than the bare rudiments of most studies, before he will find that he is unconsciously making use of this knowledge in his daily work, and will want to learn more and more. It will grow on him and finally become a hobby. For a good many years the writer has ridden his hobby in the long winter evenings very much to his advantage. One year it was arithmetic, another algebra and geometry, and again machine design, always advancing by correlated studies. When study becomes irksome, the slide rule, shorthand, and the making of accurate free-hand sketches of machine parts is a good thing for a few evenings, just to "change the air." It matters little how one or where one acquires knowledge, but there is no way that will make it stick like "doping" it out for yourself, and then applying it.

## ROUGH TURNING VS. ROUGH GRINDING OF CRANKSHAFT PINS

By H. C. PIERLE\*

The manufacture of the crankshaft in the early days of automobile development was, without doubt, the hardest proposition automobile builders had to face. The machining of this one part was the cause of more lost sleep than any other part of the motor, not only to the automobile manufacturers, but also to the builders of machine tools who were asked to furnish equipment for this class of work. The line bearing of the crank never presented any serious difficulty; the stumbling block was the machining of the crankpins.

Five or six years ago, machining a crankshaft in the old way took a good deal of time. By means of special machine tools, such as crankshaft lathes and grinders, equipped with special fixtures, this time has been cut down considerably, and all the difficulties of machining have been overcome, so that the problem now is not how fast, but how much faster we can do them.

This question was naturally put up to the machine tool manufacturer, and brought up quite a discussion among the lathe and grinder builders. We will concede the fact that for finishing the pins there is no tool that can compare to the grinder, but Mr. Norton, in an article entitled "The Field for Grinding," which appeared in the January, 1910, number of *MACHINERY*, states: "There are cases where the least expensive way is to grind direct without turning, notably the greater part of crankshafts of automobiles and small gas engines." The R. K. LeBlond Machine Tool Co., as manufacturers of crankshaft lathes, naturally believe in rough turning, and this article of Mr. Norton's made us "sit up and take notice."

For this reason we wrote to several of the motor car and crankshaft manufacturers who have LeBlond crankshaft lathes in use, asking them for the average time for the machining operations on their crankshafts, and especially on the pins. We received replies from several of them, giving us the time and labor cost for the different operations—not the best time, but the average time as made by their own workmen in the shop. The results show that the lathe for roughing operations on crankshafts is still away ahead of the grinder.

We have no time on a crankshaft of exactly the same dimensions as shown by Mr. Norton, but we have on cranks that are somewhat similar. Our method of supporting the crankpin with a roller rest while doing the heavy filleting and cheeking work makes it just as easy to turn a crank with three center bearings, as with one, so there should not be any more time consumed in roughing the one than the other. The pins on the cranks taken as examples are all larger in diameter and greater in length than the crank shown in Mr. Norton's article, ranging from  $1\frac{1}{8}$  inch to  $1\frac{1}{2}$  inch in diameter, and about 2 inches long.

The following is a table giving time, cost of labor and actual cost for roughing four pins by turning, as compared with grinding only:

	A	B	Grinding
Rough turning four pins.....	12 $\frac{1}{2}$ min.	13 min.	20 min.
Cost of labor per hour.....	\$0.30	\$0.30	\$0.35
Labor cost for rough turning.....	\$0.0625	\$0.65	\$0.1165

The time and cost designated as "A" is the average given by two motor car manufacturers who make only one kind of crank. The time given by B is the average time of two crankshaft manufacturers who make many different styles of crankshafts for the trade. This probably accounts for the slight variation in the time.

Mr. Norton in his article states as follows: "The greatest economy is usually obtained by the combination of grinding with very rough turning." To bear him out in this assertion, the following table gives the time of finish grinding a crank after rough turning, as compared with his time of finish grinding after rough grinding.

	Turned Rough	Ground Rough
Finish grinding four pins.....	15 min.	20 min.
Cost of labor per hour.....	\$0.30	\$0.35
Labor cost for finish grinding.....	\$0.0875	\$0.1165

\* Address: R. K. LeBlond Machine Tool Co., Cincinnati, Ohio.

This makes the average cost of finishing four pins by the rough turned method 15 $\frac{1}{4}$  cents, and the cost of finishing four pins by the rough grinding method 23 $\frac{3}{10}$  cents.

There are several other matters outside of the labor cost which have to be taken into consideration, such as cost of wheels, handling, cost of machines, labor, etc. In roughing out pins on a grinder, the wheel wears rapidly especially on the corners, making it necessary to true it up at short intervals. It is very essential that the fillets be kept near the radius specified, and as the wheels wear more rapidly at the corners, it is necessary to take off enough at the periphery of the wheel to get the proper radius at the corners. This condition is more in evidence when the pins are oval or egg-shaped in the drop-forged cranks, due to the dies being worn and the greater depth that it is necessary for the wheel to go down to get to the proper diameter. Nine-tenths of the drop-forged cranks have heavy fins left by the trimming press, which have to be removed.

The LeBlond lathe is equipped with a cheeking tool used for this purpose, and this operation is included in the time of rough turning. One can readily see that rapid wear and cost of wheels forms an important item in crankshaft manufacture. High-speed steel at \$1.00 per pound is far cheaper than grinding wheels.

There is always more or less lathe work to do on every crankshaft, such as chasing of threads, turning of flanges (with which about 50 per cent of crankshafts are equipped), cutting off and recentering, etc. All this with the roughing, can be done in one department and when finished sent to the grinding department with only one handling. After rough grinding, the crank is sent to the lathe department for the above operations, and then back to the grinding department, making it necessary to handle the product twice. With thousands of cranks, this is quite an item of expense.

Next, there is the difference in the first cost of the two machines, and the resultant interest charges and depreciation. Considering that three lathes will do the same amount of roughing that four grinders will do, as the results in the foregoing tables show, it is a great deal cheaper to rough turn than rough grind; the help for this work is also cheaper. As one superintendent writes, "Another item in favor of the lathe work is that we have no trouble whatever in getting crankshaft men for the lathe at 30 cents per hour, while on the grinders we must pay 35 to 37 $\frac{1}{2}$  cents per hour to get good men, and they are hard to get at that."

### \*\*\* VALUE OF EXPORTS OF TYPEWRITERS \*\*\*

It is interesting to note that during the past year typewriters were exported from the United States to the value of nine million dollars, in round figures. During the same period the total export trade in metal working machinery amounted to only about seven and a half million dollars, while the total export trade in structural iron and steel amounted to about seven million, the total trade in electrical machinery to about seven and a half million, and that in steel rails to about ten million dollars. In other words, the total volume of trade of typewriters—devices insignificant in size as compared with machines—exceeded considerably the trade in either metal working or electrical machinery, and was very close to the total value of the trade in steel rails. Another interesting comparison is that made with the export of sewing machines, which were exported during the past year to the value of about eight million dollars.

Three thousand patents have been issued up to the present on airships and devices for them, and about ninety patents are issued every month on devices for rapid rising, safe alighting and stability when in motion. It is estimated that 10 per cent of the successful flights depend on the machine, 15 per cent on the motor and 75 per cent on the man. The man of indecision, poor judgment and weak nerves, or slow judgment, is as much out of place on an airship as a defective motor. All the patents granted so far on devices for increasing the stability of an aeroplane have not overcome the necessity of an aviator's having good judgment and experience.

# LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

## AN UNUSUAL CURLING DIE

The punch and die illustrated and described in this article completely forms the curl in the forked lever shown in Fig. 1 and also indicated in position in the die at *P* in Fig. 2. This piece is known as the "ribbon-reverse weighted lever" of the Remington typewriter. It is the usual practice in most cases to form the curl of such a piece in two or three operations. The first operation usually starts the bend, and the curl is

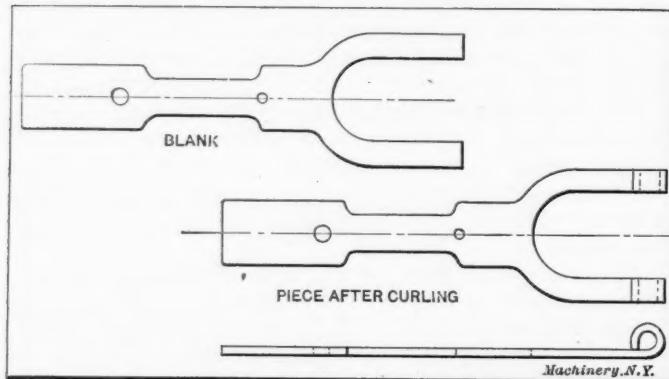


Fig. 1. Piece to be bent and Finished Product, shown Full Size

finished in the second or third operation by being formed around an arbor. However, in the present case the eye is completely formed in one stroke of the press in a vertical-acting punch and die.

In Fig. 2, *Y* is the base of the die made of cast iron; to this base are attached the other working parts, the principal one being the clamp or jaw *G*. This jaw is provided with a nest for holding the piece to be operated upon. It rocks on

*N*. This plunger is provided for equalizing the pressure on *G* and for preventing excessive torsional or twisting strain.

A further downward movement of the ram causes the ears *O* on the plunger to engage and bear against the front or outside of the jaw and the rear of the base, thus holding the jaw securely in the upright position and preventing it from springing back. A hardened and ground bearing plate of tool steel is provided in the rear of the base, where it engages lug *O*, to prevent excessive wear. The grooved former *R* next comes in contact with the top of the work and starts the curl. It continues its downward movement until the end of the stroke, when the eye is finished. The supporting pad *W* is depressed in the meantime, sliding in the block *S*. On the up stroke of the press the pad is returned to its normal position by the spring shown at *T*. The jaw is released by the raising of the action-pin *I* and falls back by gravity into the position shown to the left in Fig. 2. It is aided in falling back by the spring *U*, secured to the back of the base and to the stud *V* at the bottom of the jaw. In the view to the right in Fig. 2 the finished curl is indicated by dotted lines.

On account of the extreme ease of loading and the rapidity of action of this punch and die, as well as on account of its unique construction and the economical production made possible by its use, it will no doubt prove of interest to many mechanics.

DESIGNER

## EMPLOYMENT CARDS USED IN WORCESTER POLYTECHNIC INSTITUTE

The accompanying illustrations Figs. 1 and 2, show the card used at the Washburn Shops of the Worcester Polytechnic Institute for keeping a record of the employes. Although our shops are not large, employing only about fifty mechanics, the same problems of employment are presented as in other in-

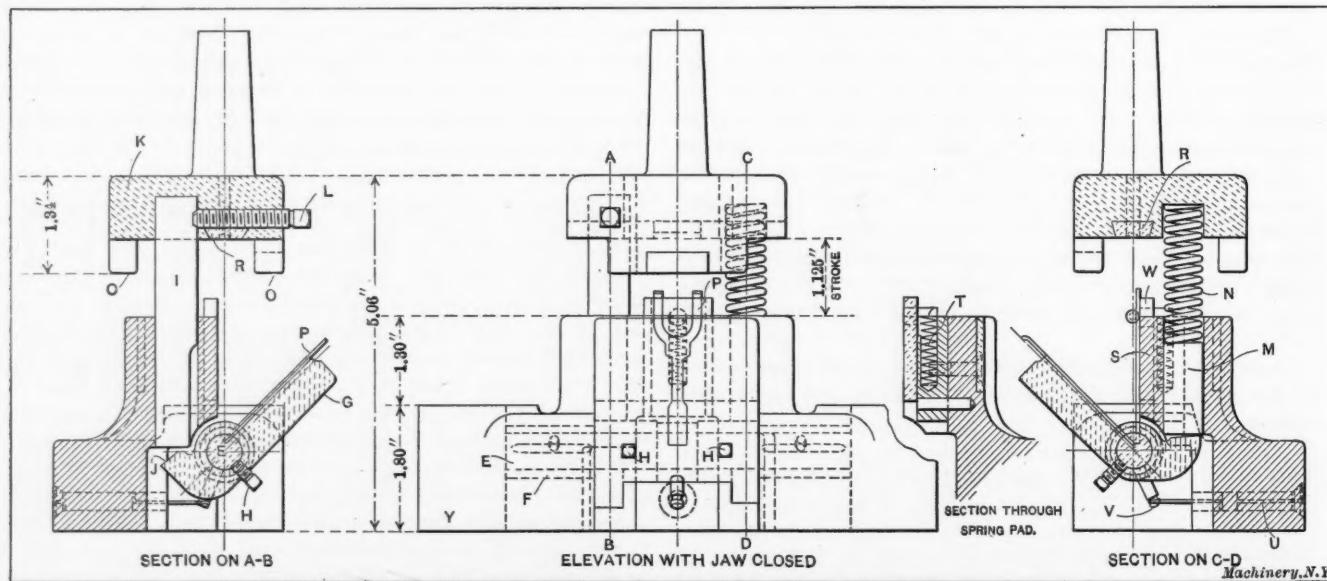


Fig. 2. Curling Die for Typewriter Part shown in Fig. 1

the shaft *E*, the ends of which turn in hardened and ground bushings *F*, which are provided to protect the base from excessive wear. The bushings are provided with oil holes as indicated. The jaw is not fitted tightly to the shaft, that is, the shaft is not a drive fit in the jaw, but is fastened to it by two small set-screws *H*. This feature allows the jaw to be adjusted at exactly the correct angle, and also permits of easy and quick dismounting in case of repairs.

When the press starts its downward movement, the action-pin *I* bears against the lug *J* on one end of the jaw *G*, causing the latter to swing up into a vertical position. The action-pin is secured in the tool-steel plunger *K* by the set-screw *L*. At the opposite side of the plunger, and bearing against an opposite lug of the jaw *G* is a short plunger *M* actuated by spring

*N*. This plunger is provided for equalizing the pressure on *G* and for preventing excessive torsional or twisting strain. A further downward movement of the ram causes the ears *O* on the plunger to engage and bear against the front or outside of the jaw and the rear of the base, thus holding the jaw securely in the upright position and preventing it from springing back. A hardened and ground bearing plate of tool steel is provided in the rear of the base, where it engages lug *O*, to prevent excessive wear. The grooved former *R* next comes in contact with the top of the work and starts the curl. It continues its downward movement until the end of the stroke, when the eye is finished. The supporting pad *W* is depressed in the meantime, sliding in the block *S*. On the up stroke of the press the pad is returned to its normal position by the spring shown at *T*. The jaw is released by the raising of the action-pin *I* and falls back by gravity into the position shown to the left in Fig. 2. It is aided in falling back by the spring *U*, secured to the back of the base and to the stud *V* at the bottom of the jaw. In the view to the right in Fig. 2 the finished curl is indicated by dotted lines.

The front of the card, Fig. 1, indicates data which is type-written upon the provided lines, when the applicant enters

the employment of the Shops. During his employment this face of the card is to the front in the index file. The reverse face, Fig. 2, is completed when for any cause whatever he ceases to be employed by the Shops, and bears the employee's

Name		Check No.	Locker No.				
Address							
Single	Married	Widower	No. in family				
Age		Nationality					
Trade							
Last employed by		Reasons for leaving					
Signature							
Date	Dept.	Rate per Hour	Day	Date	Dept.	Rate per Hour	Day
(Over)							

Fig. 1. Front Face of the Card, used when Applicant enters the Employment of the Washburn Shops

signature as well as that of the department foreman. The card is then filed with this face out, thus showing that the term of employment is finished. The data shown on the card is that common to any employment department, and gives the

Employed		to
Name		
Has returned all tools, checks, keys, etc., belonging to The Washburn Shops and is entitled to his wages in full to date.		
He has been laid off. He has been discharged. He quits voluntarily.		
Foreman of		Dept.
\$	Worcester, Mass.	191
Received of The Washburn Shops		
100 Dollars		
in full payment of all wages to date.		
Remarks:		
(Over)		

Fig. 2. Reverse Face of the Card, used when Employee severs his Connection with the Shops

superintendent a complete record of his employees, easily accessible. This is in direct line with the modern methods of shop management and modern business methods.

Worcester Polytechnic Institute. H. P. FAIRFIELD

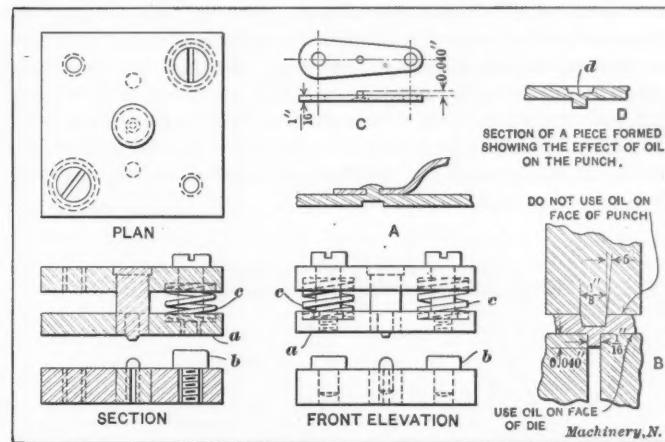
### PUNCH AND DIE FOR FORMING RIVETS

A cheap and efficient way of riveting pieces together is sometimes accomplished by making the rivets solid with one piece—that is, forming the rivet from the piece itself, and punching a hole in the other part which is to be riveted to the first part. The manner in which the pieces are riveted together is shown at A, in the accompanying illustration.

The punch and die used for forming the projection or rivet for attaching a spring to a piece is shown by the three views in the accompanying illustration. It consists of a punch and die, attached to a sub-press die by means of cap-screws which are located in the punch-holder and die-holder respectively. The stripper-plate *a* does not come in contact with the stock, except when stripping it from the punch. When the punch is acting on the blank, the stripper-plate rests on the studs *b*. The reason for having the stripper-plate work in this manner, instead of resting on the stock, is to strip the stock from the punch, after it has been lifted out of the die by the punch. This prevents the work from clinging to the die, which would be the case if the stripper-plate rested directly on the stock when the lug was being formed. The height of these studs *b* should be greater than the thickness of the stock plus the length of the projecting lug, and they

should be located directly under the tension springs *c*, so as to obviate any tilting tendency.

An enlarged view of a section of the punch and die with the stock in position is shown at B, where the dimensions used for forming the projecting lug on the piece shown at C are given. A good grade of lard oil should be used on the face of the die, but no oil should be used on the punch. If oil is used on the punch it will form a small dent *d* in the piece, as shown at D. The punch should be given about a five-degree taper on each side so as to facilitate stripping. A five-degree taper is about right for cold-rolled steel. The hole in the



Punch and Die used for Forming Rivets

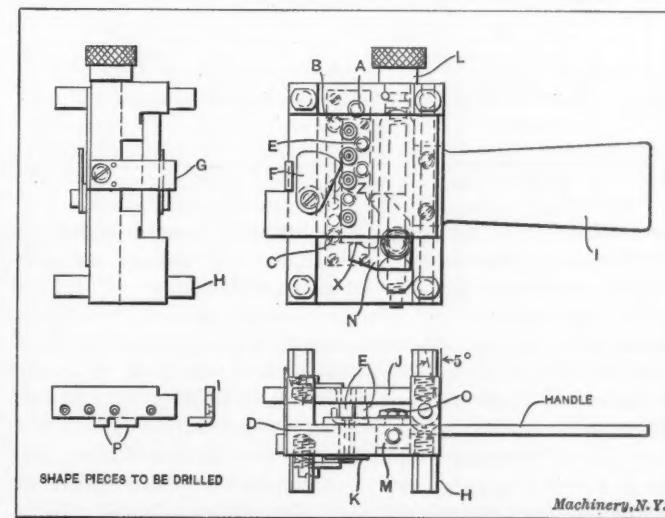
die is made perfectly straight and smooth. This method of forming a rivet without having the stripper-plate rest on the stock, bends the stock a slight amount, but not enough to cause any great inconvenience.

D. A. C.

### ADJUSTABLE DRILLING AND COUNTERBORING JIG

The jig shown in the accompanying illustration was designed in a shop where the writer was until recently employed, for drilling and counterboring different widths of pieces as shown to the left in the illustration. As there are many points in this jig which may be of interest to readers of MACHINERY, the writer will endeavor to describe them in the following:

There were some sixty different widths of pieces and the jig was designed to be adjustable for all of them. The drilling



Adjustable Drilling and Counterboring Jig having Some Novel Features

is done from the bottom of the jig and the counterboring from the top. The end of all the pieces is located against the pin *A*, and the side of the piece with the ears *P* is located against the pins *B* and *C*. As the position of the lugs varies in pieces of different lengths, several holes are provided for the pin *C*, the pin being placed in the hole suitable for the particular piece being operated on. The work is laid on the bottom of the jig and when the leaf *J* is brought down, the work is

clamped by the pin *E*. A swinging cover *F* is provided on both the top and the bottom of the jig to cover over the bushing not used in drilling the pieces of shorter lengths. The spring latch *G* is clearly shown and needs no further explanation. This jig is provided with separate and detachable feet *H* and also with handle *I* for convenience in handling.

A point to be remembered in the design of handles for jigs is that they should always be placed so that they come at least one inch above the drill press table, even if it is necessary to make the feet exceptionally long, as otherwise there is not sufficient room under the handle for convenience in manipulation, and there is also danger of the jig being tilted if the hand cannot freely pass under it.

An important point regarding the leaf *J* which is often overlooked is the angle of five degrees at the back. It is seldom necessary for the leaf of the jig to lie back flat or in a horizontal position when open, but it should nevertheless be inclined slightly from the perpendicular, so that it will stand open without being held. A casehardened piece *K* is provided

length within the limits of the jig by simply adjusting the screw *L*. This is as good an example of an adjustable jig as the writer has seen for some time.

NEW HAVEN

### METHOD OF LAYING OFF LINES FOR LETTERING

In making drawings where there are a large number of details which require the making of a material list, or a list of operations, it is a tedious job for the draftsman to lay off the lines for the lettering. To overcome this difficulty the following method was devised, which not only relieves the tedious operation of laying off the lines, but also results in a considerable saving of time. This device consists in the making of forms from stiff cardboard with lines ruled on them at a distance apart equal to the height of the lettering. The columns are also ruled off, and are printed in as shown in Figs. 1 and 2. Reading from the left of the material list,

Fig. 1.

Fig. 1. Form used in Laying off Lettering for Material List

Fig. 2.

Machinery N.Y.

Fig. 2. Form used in Laying off Lettering for List giving Order of Operations

around the bushing to prevent the drill from marring the body when it "misses fire," that is, when it "misses" the hole. When worn, this part may be easily replaced.

We now come to the most interesting part of the jig—the adjustable clamp. This consists of several parts, *L*, *M*, *N*, and *O*. The screw *L* on which the trunnion plug *M* is held rests in the body of the jig, passing through a hole in each side. A groove is cut in one end of this adjusting screw *L*, and a 3/32-inch pin passes through the jig close to the side of it, preventing the screw from pulling out and allowing the trunnion plug *M* to be adjusted longitudinally across the jig. The trunnion block *M* carries the clamp *N* which is secured to it by a nut and washer *O*, and when the screw *L* is turned, it carries the clamp *N* along the surface of the jig. When the point *X* of the clamp *N* starts to bear against the end of the work, the clamp revolves on the trunnion and the point *Z* is brought against the edge of the work. One-half turn of the screw *L* loosens the clamp sufficiently to allow the work to be removed. It will be plainly seen that the position of the clamp can be varied. This clamp will hold pieces of any

Fig. 1, the first column gives the number of pieces required; the second column gives the name, or the shop number of the part; and the third column gives the size of the material used in making the part. Reading from the left, the first column in Fig. 2, gives the number of pieces required; the second column gives the name, or the shop number of the part; the third column gives the order of operations; the fourth column gives the number of the jig or die used for performing the operation; and the fifth column gives the size of the stock or pattern number.

The oblique lines shown in Figs. 1 and 2 serve to keep the slant of the letters uniform. The space at the bottom of these forms is used for the name of the machine, the drawing number and other details. These cards are made out for 50 detail numbers, which is about the longest list that is really necessary. Every fifth line is numbered, beginning at the bottom, the reason for which will be explained later.

To use these forms, a space is left at the right-hand corner of the drawing, and when the tracing has been finished the card is slipped under it, and the list filled out, using the lines

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on the form as guide lines for the lettering. If the number of items or lines of lettering required are counted before the lettering is done, it is an easy matter by referring to the numbers at the edge of the form, to start the list in the correct place, so that the last item will occupy the last line above the space reserved for the name and other information given in the title on the drawing. The list is then ruled off, drawing the lines a short distance below the lettering.

Fig. 3 shows a part of an operation sheet completed. Here the title, the name of the part and the number of the pieces

Pieces	Part	Operation	Die No.	Stock	
2	Pedals	Part & pierce	385	$\frac{1}{8} \times 1 \times 22$	
		1st. Form	386		
		2nd. "	387		
		Part & pierce endholes	223	$\frac{1}{8} \times \frac{1}{8}$ angle	
		Pierce wide side	493	5' 9" long	
		" narrow side	285		
		Notch	224		
		Offset ends	419		
		Form	225		
THE BLANK MFG. CO.					
AURORA ILL.				N° E 319	
10-16-08 — SCALE 6"-1 FT. — DRAWN BY E.J.G.P.					
REVISED 11-14-10					
Machinery, N.Y.					

Fig. 3. Part of an Operation List Completed

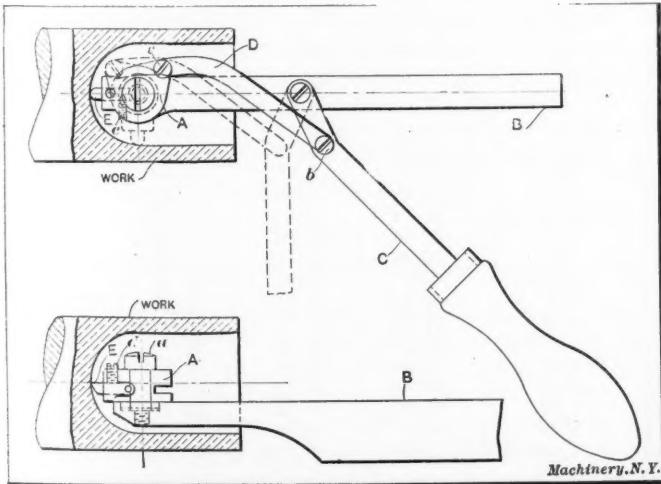
are underlined, which makes them stand out more plainly. The various operations to be performed on each part are enclosed with a bracket to avoid any possible misunderstanding. When revisions are made, a note is added at the bottom of the card, as shown at the lower left-hand corner in Fig. 3. Another advantage of this method, is that the lists are easily kept of a standard form, and those who use the blueprints become familiar with them, which avoids confusion.

Aurora, Ill.

E. J. G. PHILLIPS

## TURNING TOOL FOR BALL SOCKETS

The accompanying illustration shows a simple tool which can be used for turning ball sockets or other internal spherical work. This device consists mainly of the tool-holder *A*, which is held to the holder *B* by the fillister-head screw *a*. The turning-tool holder *A* is operated by the handle *C* through the connecting-link *D*, which is held to the tool-holder and



Turning Tool for Ball Sockets or Other Spherical Work

held by two fillister-head screws *b* and *c*. The turning tool *E* is held in the holder *A* by the headless screw *d*, and is adjusted outwardly by the cone-pointed screw *e*.

In operation, the shank *B* of this tool is held in the toolpost of the lathe, and is brought in line with the center as shown. Then the tool *E* is set to the desired radius and the lathe carriage advanced bringing the tool into the hole in the work to the desired depth. When in this position the handle *C* is turned to the left, thus forcing the tool-holder carrying the turning tool *E* to the right. The movement of the tool when turning a socket is clearly illustrated by the full and dotted

lines. The dotted lines show the position of the lever at its extreme stroke, or in other words, when the radius is completed. Turning tools of various lengths are used for turning different radii.

Philadelphia, Pa.

JOHN L. ZANZINGER

## A BORING FIXTURE FOR THE LATHE

On a certain machine that we were building there were several different brackets in which the distance from the base to the center of the hole was the same in each case, but the brackets were not all of the same shape. About twenty-five of these machines were to be built, so a fixture was made as shown in Fig. 1 for boring the holes. A discarded lathe was brought up from the basement, the cross-slide removed and the fixture fastened to the slide of the carriage. The reason for using the lathe was that our boring machines were all busy on large work. To hold the fixture to the carriage a pin was driven through it and into the slide of the lathe, thus holding the fixture, so that it was approximately

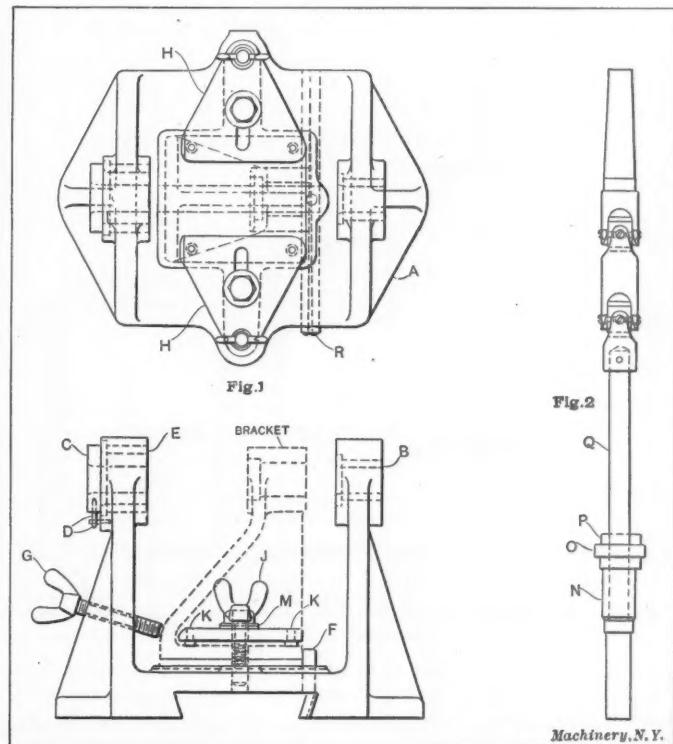


Fig. 1. Fixture used on the Lathe for Boring out Brackets. Fig. 2. Boring-bar used in Connection with the Fixture shown in Fig. 1

in line with the lathe centers. It was not entirely necessary that it should be exactly in line, as the universal joint in the boring-bar, Fig. 2, would take care of any variation.

This fixture is of simple design and is made of cast iron. The frame *A* is well ribbed and holds the bushings *B* and *E*. The bushing *B* is the smaller of the two, being a good fit for the boring-bar, and is forced into the fixture. The bushing *E* is also forced into the fixture, but the hole in it is large enough to clear the stop-collar *O* on the boring-bar. *C* is a bushing which supports the boring-bar and is held in the bushing *E*. It is kept from turning by the two pins *D*, one of which is driven in the fixture and the other in the shoulder of the bushing. A slot  $\frac{1}{4}$  inch wide by  $\frac{1}{4}$  inch deep is cut in the bottom of the bracket and a key is held in the fixture to fit in this slot, thus holding the bracket in line with the center.

The bracket is held against the stop-pin *F* by the wing-screw *G*. The clamps *H*, one of which is placed on each side of the fixture, hold down the casting to the base of the fixture, and have two bearing points which are made by driving shouldered pins *K* into them. These pins hold the casting down in a better manner than a perfectly flat surface would. The clamps are held down by wing-screws *J*. These clamps have an elongated slot cut in them, so that they may be pushed back out of the way to facilitate the removal of the casting. Coil springs are placed under the washers *M* held on the wing-

screws *J*, so that they always keep the clamps tight up against the washer, and thus facilitate their being pushed back.

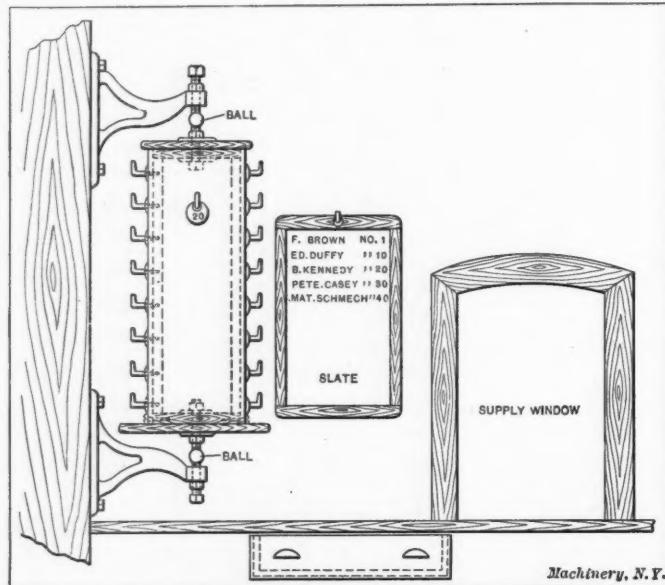
The boring-bar, Fig. 2, is also of simple design and is made from a good grade of tool steel. *N* is a combination reamer and counterbore, and *O* is a stop-collar for limiting the depth of the counterbore. The counterbore and stop-collar are held on the boring-bar by the key *P* which fits in a slot cut in the bar *Q*. The ordinary feeding arrangement of the lathe was used for boring out these castings. This boring-bar is held on the lathe centers and driven by an ordinary dog.

Bristol, Conn.

WALTER J. OLDBOYD

### CONVENIENT CHECK HOLDER FOR THE TOOL-ROOM

The accompanying illustration shows a very convenient check holder for use in the tool-room. It will hold 1000 or more checks conveniently, and is placed near the window of the tool-supply room. The check holder proper consists of a wooden cylinder 6 inches in diameter by 24 inches long, with a circular plate fastened to each end. Two balls are held



A Convenient Check Holder for Use in the Tool-room

between the cap-shaped ends of the screws shown, thus facilitating the rotating of the cylinder. There are 100 hooks screwed into this cylinder, which is sufficient for holding 1000 checks.

The use of this check holder is as follows: Each man is allowed ten checks, which are not given to him, but are placed on one of the hooks, and his name and number are written on a slate which is shown to the right in the illustration. Now when this man calls for a tool his check is taken from the hook, and put in the place that the tool occupied, and when he returns the tool, the check is taken out and replaced on his hook. This avoids the inconvenience of a man having to carry his checks around with him, and also prevents the liability of losing them. Of course, it is an easy matter when a man leaves the works to erase his name from the slate and substitute the name of the man taking his place and number.

J. W.

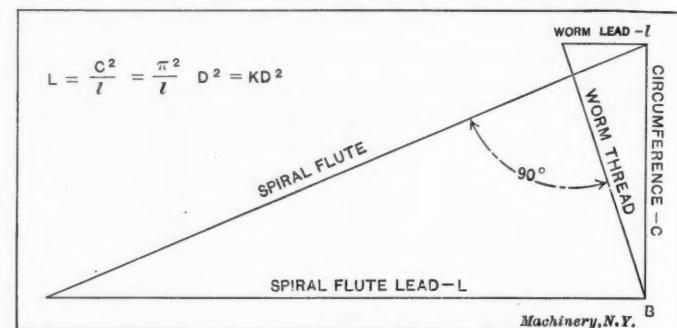
### DETERMINING THE LEAD OF SPIRAL FLUTES IN WORM HOBS

When relieving hobs by hand filing as is done in most shops that are not equipped with a relieving attachment for one of the lathes, the following table gives a quick method of obtaining the lead for which to gear the milling machine, to cut the spiral flute at right angles to the worm thread. If, however, a relieving attachment is available the lead should be figured out by a method suitable for this relieving attachment.

To find the lead *L*, simply square the outside diameter and multiply by the constant found in the table. An example will serve to illustrate: Consider a triple threaded worm hob with 4 threads per inch and 1 1/4-inch outside diameter. It is de-

sired to find the lead for cutting the flutes so that the outside cutting edge is square across the worm tooth. First, square the outside diameter,  $(1.750)^2 = 3.062$  inches. Then multiply by 13.16, the constant found in the table for a triple threaded worm of 1/4 inch pitch. This gives 40.3 inches as the flute pitch.

To proceed with the cutting, refer to the tables furnished with the milling machine and select gears for the lead nearest



Development of Spiral Flute for Given Worm Pitch

to 40.3 inches and find the angle to which to set the milling machine table for this lead and a diameter of 1 1/4 inch. This done, all the information necessary to finish the job has been found.

The values in the tables were obtained as follows: In the engraving, which represents the surface of the worm hob unwrapped or developed, *l* equals the lead of the worm; *C*, the circumference; and *L*, the lead of the spiral flutes. Here

are two similar triangles from which  $\frac{L}{C} = \frac{C}{l}$  which reduces to  $L = \frac{C^2}{l}$ . Substituting  $\pi D$  for *C* gives  $L = \frac{(\pi D)^2}{l}$ .

Taking  $D^2$  out, leaves  $L = \frac{\pi^2}{l}$ . The value of the expression  $\frac{\pi^2}{l}$  can now be calculated for the various single, double, triple, etc., worms, which results are here tabulated.

CONSTANTS FOR DETERMINING THE LEAD OF SPIRAL FLUTES IN WORM HOBS

Pitch of Worm, Inches	Type of Worm			
	Single	Double	Triple	Quadruple
3	3.29	1.64	....	....
2	4.93	2.47	1.64	1.64
1 1/2	6.58	3.29	2.19	1.64
1 1/4	7.90	3.95	2.63	1.97
1	9.87	4.93	3.29	2.47
1/2	19.74	9.87	6.58	4.93
1/3	29.61	14.80	9.87	7.40
1/4	39.48	19.74	13.16	9.87
1/5	49.35	24.67	16.45	12.34
1/6	59.22	29.61	19.74	14.80
1/7	69.09	34.54	23.08	17.27
1/8	78.96	39.48	26.82	19.74
1/9	88.83	44.41	29.61	22.21
1/10	98.69	49.35	32.90	24.67
1/12	118.44	59.22	39.48	29.61
1/14	138.17	69.09	46.06	34.54
1/16	157.91	78.96	52.64	39.48

The expression  $L = \frac{C^2}{l}$  may be useful otherwise, as it shows the relation between the lengths of the leads of two spirals (strictly speaking helixes) which are at right angles to each other on the same diameter.

G. V. ANDERSON

Walpole, Mass.

[The author chooses the outside diameter of the hob in preference to the pitch diameter for reasons of convenience both of measurement and of backing off the teeth by hand for clearance. It is assumed that the difference in cutting action of hobs fluted at right angles to the worm thread at the top of the teeth and to the thread at the pitch line is of little importance.—EDITOR.]

## THE SYSTEMATIC SCRAP-BOOK

In the January issue of MACHINERY, "Designer" takes exception to the writer's article which appeared in the November number, in which a system for the systematic compilation of a scrap-book was described. Especial exception is taken to the index described in connection with the scrap-book. The writer acknowledges some merit in the method employed by "Designer," but believes he has failed to grasp the scope and unlimited expansibility of the system described in the article in question.

"Designer" has described a method employed by himself, for saving the valuable information which comes to him through the medium of MACHINERY, and to this extent we will acknowledge the simplicity of same, although his method is not without its drawbacks even in caring for the pages of MACHINERY. He states that where there is a page on which are articles on two or more subjects, the page is cut up and the different articles pasted on blank pages, each under its correct heading. What if these different articles occurred on the same leaf in such a manner that one could not be cut out without destroying the others? It would then be necessary to file the page under one of the articles and to file blank pages referring back to the others. This would necessitate looking twice before finding the reference, and as the book increased in size, more and more trouble would be experienced from this source. If "Designer" desired to preserve pages from some publication of larger size than MACHINERY, it would be necessary to begin another book, and so *ad infinitum*. In course of time, then, if he desires to look up some particular subject, he will commence in one book, look through all the pages filed under that guide and, not finding what is wanted, take up the next book and so on, perhaps not finding just what is wanted after looking through them all.

Compare this method with that of looking at a card, found in a moment's time under its proper heading or sub-heading in the index, whereon will be listed *all* the articles pertaining to the topic sought, giving directly the page numbers of the various books wherein those articles occur. It will be remembered that in the writer's system all books were numbered to facilitate indexing; the word "books" as used above includes any text-book, bound volume of magazines, scrap-book or catalogue owned by him. As to the time required to keep up the card index, the writer will index an article under his system in less time than "Designer" can insert a page under the proper guide.

The card index system previously described can hardly be classed as "elaborate" or "laborious," as such a system applied to various requirements has proved to be a time-saver the world over. "Designer's" method will work very well for one book, but it must be remembered that the system described and used by the writer covers an entire library and is unlimited in its applicability and expansibility.

Muskegon, Mich.

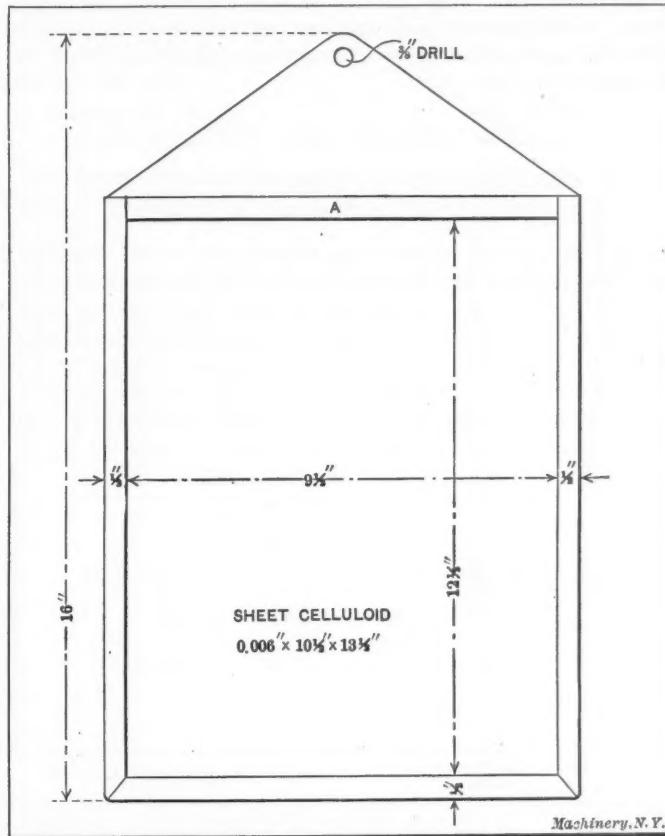
R. E. ASHLEY

## MOUNTING BLUEPRINTS FOR SHOP USE

In the December number of MACHINERY J. B. & Co. ask for an efficient and cheap method of mounting blueprints for shop use. This, I understand, refers to blueprints which are sent to the shop for some certain job, and at the completion of which are returned to the drafting-room; not those which are held as reference prints and which remain permanently filed in the shop.

In our shop, for instance, when we want to send a print of a jig to the tool-room, it is mounted in the holder shown in the accompanying illustration. This consists of a sheet of white transparent celluloid, about 0.006 inch thick, a little larger than the print, and a piece of sheet tin, the edges of which are crimped over, holding the celluloid firmly on three sides; the top is left open for the insertion of the sheet. The top edge of the celluloid has a strip of tin A crimped over it also, to protect it from tearing. A hole is drilled in the tin at the top, by which the frame may be hung. As several sizes of prints are used it is necessary to have holders for each size.

No treatment of the print, such as shellacking, etc., is necessary; it is simply slipped into the frame behind the celluloid, which effectively protects it from grease and dirt, and as thin celluloid is very transparent, the figures can be plainly read. The frames can, of course, be used over and over again, and will last for years, so that, exclusive of the first cost, the expense is very slight. The celluloid can be easily cleaned of grease and dirt which may collect on it.



Frame for Holding Blueprints

The suggestion offered by the editor, of using strawboard of suitable thickness, to which the prints are pasted, is one which is widely used and serves very well, but the prints should be shellacked on the front as they soon get dirty if handled much.

Prints as large as 18 by 24 inches have been put in holders like that shown in the illustration; but these holders are more often used for such sizes as 6 by 9, 9 by 9 or 9 by 12 inches.

DESIGNER

## SOME SUGGESTIONS FOR INDEXING BOOKS

In an article entitled "Some Suggestions for Indexing Books," which appeared in the January number of MACHINERY, Mr. Myers elaborates extensively upon what seems to the writer to be a fantasy; he suggests a reform in indexing which would itself speedily require revision. A change in the present method used in the majority of cases would not be criticized, but the improvement should be in the manner of assemblage, and not in the plan. As Mr. Myers mentions, the commonly-accepted system appears to be based on common sense; it is concise, and, when properly used, of the greatest simplicity. The engineer who has recourse to handbooks and trade catalogues does not need an illustration of a set-screw, stud, or tap-bolt to locate a reference.

The application of the pictorial method to the Carnegie hand-book, was not a very good example, as the proposed index could not be as useful as the present index sheets of this book. The heavy condensed type used in marginal style for key-word finding, and the various miscellaneous indented notes directly following, with leaders to the page number, is a commendable arrangement. Allowing that a pictorial index might be satisfactory for a small trade publication, it is difficult to see where it could be usefully employed in index-

ing "Kent" or "Trautwine," or a volume of *MACHINERY*'s data sheets. This would be emulating the ancients in the use of hieroglyphics to a superlative degree, and the result would be one of absolute perplexity.

Current practice in general offers matter classified principally under the name of the article or topic; such classifications are useful in an assemblage of the subject matter. Referring to "Kent," we find "machine screw taps" indexed under "Machine" and "Taps;" similarly "helical springs" comes under "Helical" and "Springs," and so on. This gives a sufficiently simple arrangement, and one which it would be difficult to improve upon.

Los Angeles, Cal.

L. R. W. ALLISON

### A RECESSING OPERATION IN THE AUTOMATIC SCREW MACHINE

A screw machine operator frequently runs across some interesting jobs in different shops. The writer has always made it a rule to keep a memorandum of these jobs, so that they may be referred to when setting up a machine for other parts of a similar character. It is also a good plan to keep a record of errors, because what often seems to be the best method, proves to be a failure in practice. This is particularly true

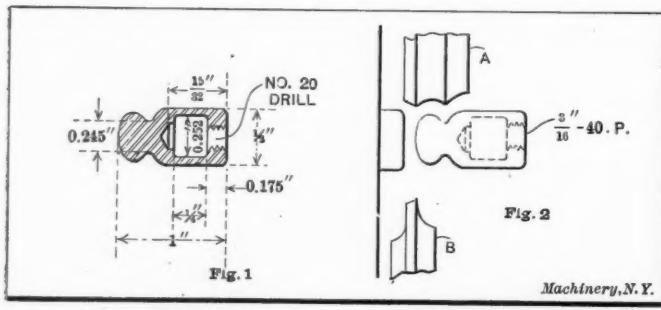


Fig. 1. The Piece to be made

Fig. 2. Arrangement of the Circular Tools

of screw machine work, as there are so many different methods of tooling some parts that it is difficult to determine which is best.

The piece shown in Fig. 1 was made by a cash register concern some time ago, and it gave plenty of trouble before it

by referring to the table in the B. & S. book we find that the nearest spindle speed is 663 revolutions per minute.

The recessing is performed with a B. & S. standard swing tool, which is the tool usually selected for this class of work. The recessing cutter is first fed at right angles to the spindle by the cross-slide, after which it is fed forward by the turret. The feeds given in the following were found to be sufficiently light, and the tools stood up well without continual sharpening.

The method of setting the circular tools on the machine is shown in Fig. 2. The circular form tool A is located on the back-slide, and the cut-off tool B, on the front-slide. The form tool operates while the hole is being drilled; this is practicable, because the smallest diameter to be found is 0.245 inch, while the diameter of the drilled hole is 0.161 inch. The surface speed of the drill is only 28 feet per minute, as the machine spindle cannot be run faster on account of threading. Some operators prefer a high-speed drilling attachment for this kind of work. The order of operations for making this piece is as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop.....	13	3
Form 0.128 inch rise at 0.001 inch feed .....	(128)	(29)
Revolve turret.....	13	3
Center 0.090 inch rise at 0.005 inch feed .....	18	4
Revolve the turret.....	13	3
Drill 0.512 inch rise at 0.004 inch feed .....	128	29
Revolve the turret.....	13	3
Recess 0.050 inch rise at 0.0028 inch with rear cross-slide.....	18	4
Recess from turret 0.250 inch rise at 0.0051 inch feed.....	49	11
Drop back rear cross-slide.....	9	2
Revolve turret.....	13	3
Thread in .....	9	2
Thread out .....	9	2
Cut off 0.274 inch rise at 0.002 inch feed .....	137	31
Revolve turret twice.....	(26)	(6)
Total number of revolutions to make one piece.....	442	100

With this layout a piece is made every 40 seconds, which means a gross production of 900 pieces in ten hours. The cams for this piece are shown in Fig. 3, and consist as usual of the lead, front-slide and back-slide cams.

By referring to Fig. 3 it will be noticed that the rear-slide cam has a lobe from 45 to 60 on the cam circle. The use of this portion is as follows: At 45 the recessing tool is brought into place by the lead-cam, the rear-slide cam moves forward 0.050 inch feeding the recessing tool in to take the depth of chip required. Then from 49 to 60 the form cam has a dwell while the recessing tool moves forward; the allowance from 60 to 62 is made to withdraw the back-slide before withdrawing the swing tool.

S. N. BACON

### A HANDY KNIFE SHARPENER

While the knife should be used sparingly upon tracings for erasing purposes, it is in many cases necessary. In order to make a really good job when scratching out with the knife, it is very important to have the blade in first-class condition; otherwise it tends to drag up more of the surface of the cloth than is desired, and if the part scratched out has to be reworked upon a poor looking job is the result.

The writer has used a "stunt" which will be worth trying: Take a strip of suitable emery cloth about  $\frac{3}{4}$  inch wide and 5 inches long, and fasten it with four small tacks to the top face of the drawer, which is invariably provided in a drawing table, usually on the right-hand side.

After having oilstoned the blade to be used for scratching out purposes, all that is necessary for keeping the blade point in good condition is to open the drawer about 2 inches and draw the blade a few times across the emery cloth, and an exceedingly keen edge can be maintained for many months without further oil-stoning.

Q. E. D.

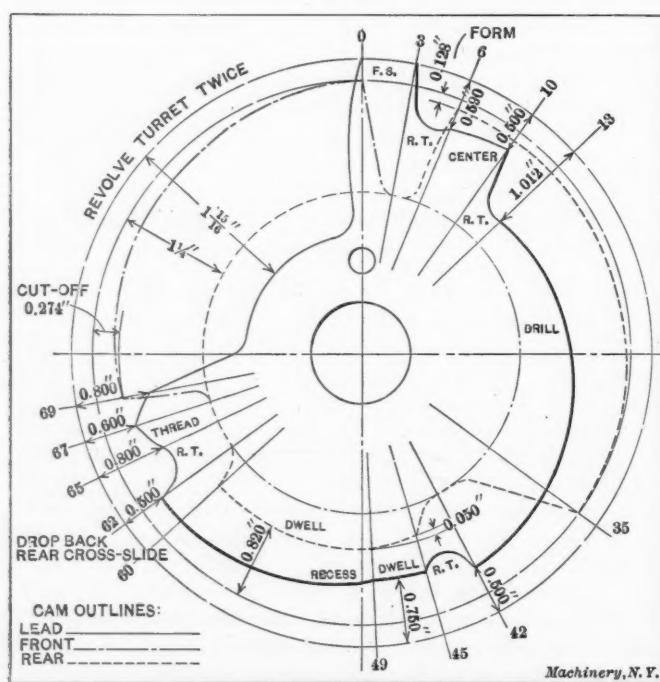


Fig. 3. Cams used in making the Piece shown in Fig. 1

was made successfully on the automatic screw machine. This piece was made from machine steel  $\frac{1}{2}$  inch in diameter, in a No. 0 B. & S. automatic screw machine. In considering the speed, we find that for forming we can run the stock at about 80 feet per minute, and thread at 30 feet per minute. This gives us 611 and 603 revolutions per minute respectively, but

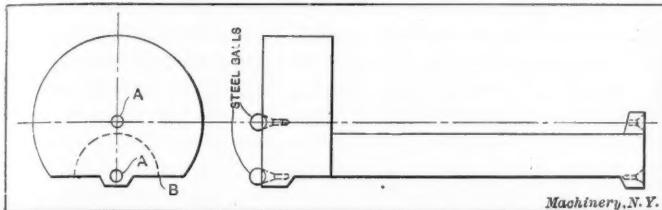
## SHOP KINKS

## PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

## TESTING THE WORK CENTERS OF AN ECCENTRIC PIECE

A short time ago a little problem came up in our shop which I thought might be of interest to the readers of MACHINERY. It was required to test the work-centers *A* of the eccentric piece shown in the accompanying illustration, in relation to a flat side *B*, at right angles to the centers.



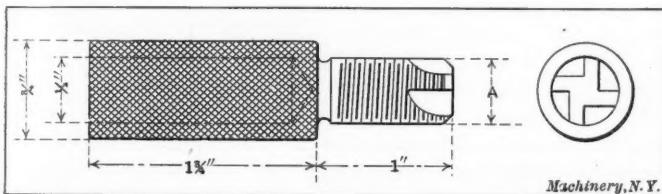
Two steel balls of the same diameter were clamped in the centers, so that a scale placed against them would be tangent to their diameters. By this means it was an easy matter to test the centers *A* with relation to the flat side *B*.

Detroit, Mich.

FRANK I. TOWER

## TOOL FOR CLEANING THE THREADED HOLE IN CIRCULAR TOOLS

The tapped holes in the circular tools used on the Brown & Sharpe automatic screw machines sometimes become clogged with chips and dirt, thus preventing the insertion of the screw. It is not advisable to clean out these holes with a tap, as since the tools are hardened, it would soon put the



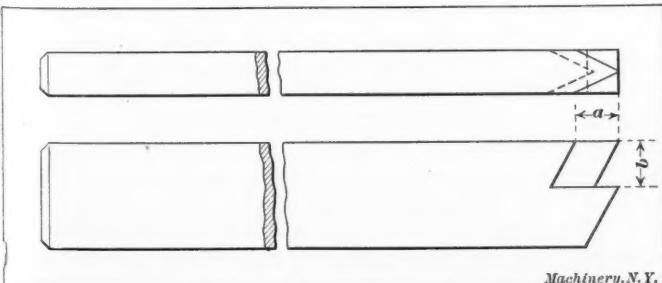
tap "out of business." A tool which can be used for this class of work is shown in the accompanying illustration. This is a piece of tool steel, knurled on the handle, as shown, and threaded. Grooves are filed in the forward end of this tool, after which it is hardened. The dimension *A* is made to suit the threaded holes in the circular tools for the various machines.

F. W. RANDALL

New Haven, Conn.

## HIGH-DUTY SPLINING TOOL

The accompanying sketch shows a splining and key-seating tool, which the writer has used for some time with very satisfactory results. It consists of the usual square nose tool, with



the front part ground V shape, thereby forming two portions to the tool. The V part divides the cut into three sections, one being taken by the V, and the other two by each of the corners of the lower square section. The chip being thus divided, less power is required for taking the cut, and a better job is produced. The side clearance of the V acts on the back chip in a

precisely similar manner to the groove or top-rake of a twist drill; and so the square point in following the V, has a tendency to cause the chip to coil up, guiding the chips to both sides.

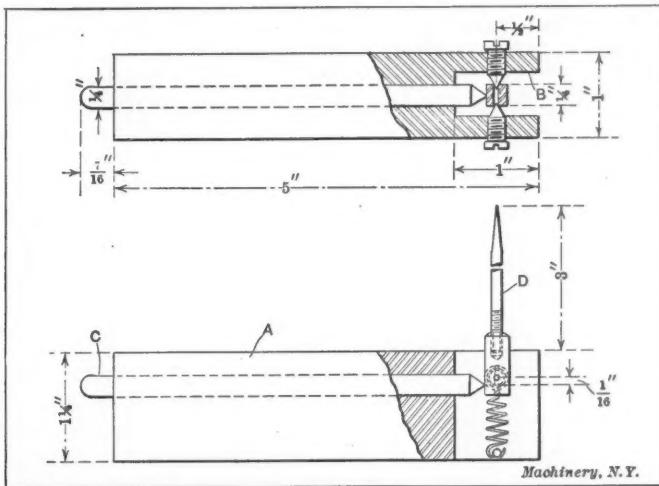
In practice, *a* is always made at least twice the depth to which the cut is to be made, for if the tool were to enter the full depth of a cut the back chips would tend to clog. Observing this caution, no difficulty will be experienced.

This is a tool which will meet the general desire for "hogging" service, for experience has shown that it does not chatter, and will therefore stand more severe service than the ordinary square tool.

CHIPS

## INDICATOR FOR TRUING WORK

The accompanying illustration shows a very simple indicator for truing work in the lathe. The body *A* of this indicator is made from a piece of  $1\frac{1}{4}$ -inch by 1-inch machine steel 5 inches long. It is slotted at *B*, and an indicator needle is held in a square block, as shown. This square block is held by two



cone-pointed screws, thus allowing the needle to swivel. A coiled spring is attached to the block holding the needle, to steady it and hold it against the cone-pointed rod *C*. The rounded end of this rod bears against the periphery of the work, and any irregularity or eccentricity of the work is shown by the deflection of the needle *D*.

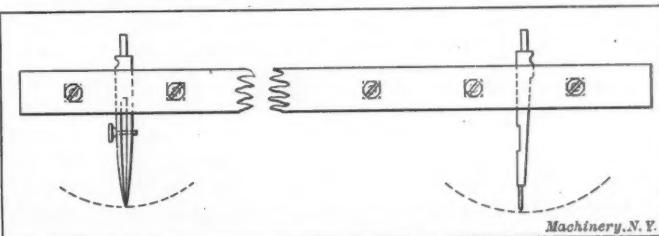
Joliet, Ill.

REX MCKEE

## BEAM COMPASS

The accompanying sketch illustrates a beam compass that was made on an occasion when such an instrument was needed badly and there was none in the draftsmen's outfit.

We had in the office a number of  $\frac{3}{8}$  by 3-16-inch hardwood strips, 30 inches long, that were used for binding blueprints,



and also a box of  $\frac{1}{8}$ -inch button-head screws with square nuts that were used for the same purpose. Holes were drilled in two of these strips about three inches apart and the parts of an ordinary compass were clamped between the two strips by means of the screws, as shown in the engraving.

An adjustment of several inches could be had by swinging the pen and needle point (shown by the dotted lines) without loosening the screws. In the absence of a better instrument this proved very satisfactory.

A. N. P.

\* \* \*

Japanese lacquer is not a lacquer in the ordinary meaning of that word, but rather a varnish, being analogous to the spirit varnishes containing shellac.

## HOW AND WHY

### A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST

Give details and name and address. The latter are for our own convenience and will not be published.

#### MAKING BLUEPRINTS FROM BLUEPRINTS

Designer.—I would like some information on the making of blueprints from another blueprint. I have tried to do this but have not been able to get satisfactory results. I believe that there is some chemical by means of which the original blueprint can be treated so as to make it possible to obtain a good copy. I would be pleased if any reader of MACHINERY who has been able to satisfactorily make blueprints from other blueprints, would describe the process.

#### A PROBLEM IN SHEET METAL DRAWING

H. W.—I would like to ask through the columns of MACHINERY how to make a rectangular shell from open-hearth steel plate (No. 20 gage). The shell is 5 inches long by  $4\frac{1}{2}$  inches wide by 6 inches deep. It is also necessary to have a  $\frac{3}{8}$ -inch flange all around the box. The corners are required to be fairly sharp. How many drawing operations are required, and what difference in depth could be made in each successive drawing operation? Also, what formula could be used for determining the size of the blank?

#### SIZE OF EXHAUST FAN

J. P. McC.—What size exhaust fan is required to exhaust the emery dust from a No. 2 B. & S. surface grinder, a B. & S. No. 3 cutter grinder and an emery wheel stand with two 10-inch by  $1\frac{1}{4}$ -inch wheels; all are dry grinders. The dust would have to be drawn or blown about 40 feet.

Answered by Brown & Sharpe Mfg. Co., Providence, R. I.

A.—We would recommend an exhaust fan of about the capacity of the No. 00 "Monogram" exhaust made by the B. F. Sturtevant Co., Hyde Park, Mass. The inlet for this exhauster is  $4\frac{1}{8}$  inches in diameter and the outlet  $4\frac{1}{8}$  inches. To get the best results we would recommend placing the fan as near the machines as possible. If it were hung on the ceiling just over the machines, it probably would give the best results. Let the 40 feet of piping necessary be on the outlet side of the fan. The inlet pipe to the fan should be made full size and the branches from it for the respective machines should not enter the main pipe at right angles but should enter it at an angle of about 45 degrees inclining toward the fan. It is best to avoid all sharp bends, using curves instead of ells when making bends. We think that if a fan of the size mentioned is run at a speed of 3000 to 4000 R. P. M. it will give you all the draft necessary.

#### FORGING WRENCH JAWS

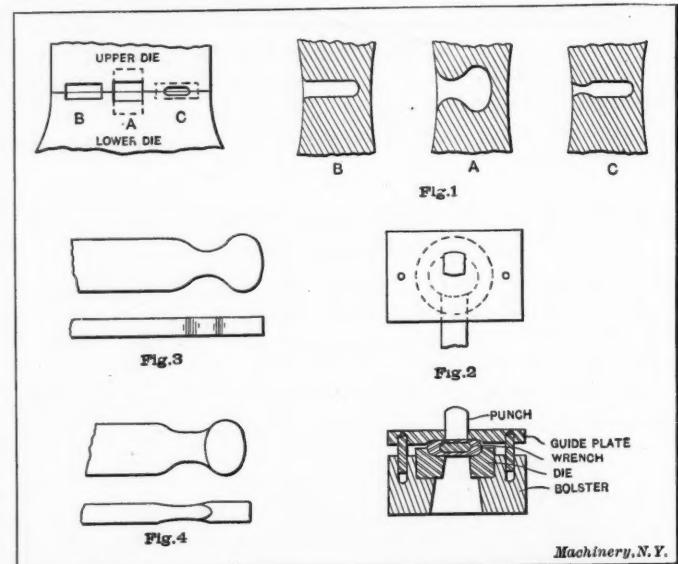
C. R. C.—How can wrench jaws be satisfactorily drop forged on a steam hammer? In our blacksmith shop we have always forged open-end wrenches by hand, which is a rather inefficient method. Cannot this work be done a steam hammer with cast-iron dies? It is proposed to forge only the jaws in this manner. No drop hammer is available.

Answered by James Cran, Plainfield, N. J.

When the number of wrenches to be made is too great to be done economically by hand, and still too limited to justify the expense of sinking steel dies, to say nothing of other necessary equipment, an ordinary steam hammer equipped with cast-iron dies answers the purpose very well. Cast-iron dies, however, to give satisfaction in the making of forgings, must be made in a somewhat different manner from regular tool-steel drop-forging dies, inasmuch as there must be no sharp corners in the impressions; nor should the dies be made to throw out surplus metal in the shape of a "flash," as is generally done in drop forging, but should be so constructed, when the shape of the pieces to be made will permit, that the forging will be without a "flash." Open-end wrenches are of a shape suitable for forging in this manner, whether they are to be S-shaped, have the head at an angle of 15 or  $22\frac{1}{2}$  degrees from the handle, or are perfectly straight. Forgings without "flashes" are made in what is generally known as "open dies," that is, the impressions are much wider than the forg-

ings to be made in them and are so arranged that one impression reduces the stock to the required thickness, and another to the shape and width, by changing the work from one impression to the other as each successive blow of the hammer is struck. This will be better understood by referring to Fig. 1, in which upper and lower steam hammer dies for forging open-end wrenches are shown. The size of stock to be used for wrenches made in the manner described, should be as nearly as possible equal to the width and thickness of the wrench head when finished; the stock may be somewhat larger, but should never be smaller.

The forging is carried out as follows: The heated stock is placed edge up in impression A and receives a blow which partly shapes it. It is then placed in impression B for the next blow, which reduces it in thickness. This procedure is continued—striking a blow in each impression alternately—until from six to twelve blows have been struck, according to the size of the wrench and the weight of the hammer used. The forging is thus reduced to approximately the shape shown in Fig. 3. To reduce the neck to about two-thirds of the thickness of the head, which is generally considered to be about



the right proportion, it is struck one or two blows in impression C, bringing it to about the shape shown in Fig. 4, which completes the forging process as far as the head is concerned.

The opening for nuts or bolt-heads can be made in various ways, preferably by milling, as that leaves them perfectly straight and smooth. Should a milling machine not be available for the purpose, a punch-press may be used, or the opening can be made under a steam hammer by using dies and punches as shown in section in Fig. 2. The cast-iron bolster could be used for all sizes, but the dies, the punches, and the guide plates would have to be made to suit each size of wrench, and interchangeable so that they would fit the bolster. It is important that punches to be used in connection with a steam hammer be short so that when they are driven through the work they will not come in contact with the lower die, and that they be slightly tapered from the face up, to prevent them from sticking in the work, should the head get battered out of shape. Both die and punch should be of tool steel, say from 60 to 75 point carbon, hardened and tempered. The writer has found that by drawing the temper of punches and dies to be used in this manner a little further than if they were to be used in a punch-press, the best results are obtained. The guide plate pins may be made of machine steel. The cast-iron forging dies will give longer and better service if they are hardened. This does not call for any elaborate process, as is generally supposed. It is done by heating the faces to about the same temperature as is required for hardening tool steel, and then coating them with pulverized raw borax, which is allowed to "cook" until it ceases to bubble. They are then placed, face up, at the bottom of the quenching tub, and allowed to remain without being disturbed until perfectly cold. Drawing the handles of wrenches to size is too ordinary an operation to call for comment.

March, 1911

MACHINERY

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**"INS AND OUTS OF GEAR HOBBING"—  
A REPLY**

By RALPH E. FLANDERS\*

The comment of Mr. Percy C. Day on the article entitled "Ins and Outs of Gear Hobbing" is intelligent and friendly, and it further emphasizes certain important points which it seems worth while referring to again.

The reason for choosing a 21-tooth gear for the experiments was very simple. It was possible to make blanks for these gears, 6-pitch, out of a 4-inch bar of steel, that being the largest diameter of stock within easy reach of the experimenter. There is nothing unfair, moreover, in choosing a small pinion and a 14½-degree angle, for the user of a gear-hobbing machine has a right to expect that he will be able to cut a pinion of that number of teeth and that pressure angle. Hobbing machine manufacturers do not warn prospective customers that such gears cannot be cut satisfactorily on the machine. It would seem that they should at least see that their customers use proper hobs. The hob was the product of one of the best toolmaking firms in the country and was sold without any warnings as to its limitations. If the hob has limitations, the purchaser has a right to know it, and he should thank any article or reports of experiments that will put him on his guard. Let him get assurance that proper correction is made in his hob for interference.

In regard to the matter of the looseness of the machine, I must not be understood as saying that the machine was really "slack" in its adjustments. It was simply set up so as to run freely, in the same way that machines are often adjusted in the average machine shop. The point is that generating machines (gear-shapers included) must be adjusted more carefully and closely than an ordinary drill press or shaper, if the most accurate results possible are to be obtained; and the hobbing machine in particular, as distinguished from other generating machines, must have unusual care taken in this respect, as well as in its fundamental design. This is owing to the fact that its generating mechanism has to carry the *whole strain of transmitting the cutting power*. In this respect it is at a disadvantage as compared with any other gear generating machine I can call to mind, whether made for spur, bevel, or any other type of gearing. The intermittent cutting strain is a serious disturbing factor in the generating action, unless great care is taken to avoid it.

This matter of the necessity for careful adjustment, as I freely confessed in the article, was a new thought to me, and was the principal personal result of the investigation. No doubt Mr. Day, with his better practical experience, knew it already. If he considers that ignorance in this matter vitiates the entire experiment so far as the symmetry of the teeth is concerned, it will surely be a most instructive and valuable undertaking if he will carry out the experiments under more nearly ideal conditions, and will report his results to the readers of MACHINERY. Will Mr. Day do this for us?

The result of the experiments on my own mind was the conviction that the torsional strain, back-lash and play is of far greater moment in the production of unsymmetrical teeth than the centering of the hob teeth can possibly be.

\* \* \*

**TIME REQUIRED FOR CLEANING  
BOILER TUBES**

In the January, 1911, number of MACHINERY, engineering edition, an article appeared entitled "Method of Handling Boiler Tubes in the Canadian Pacific Shops." In this article it was stated that by the use of a tube rumbler made by Joseph T. Ryerson & Sons, Chicago, Ill., the cleaning of 300 tubes required, on an average, from 10 to 48 hours, the variation in time depending upon the condition of the tubes. We have been informed that this statement is incorrect and that in the shops mentioned it takes, on an average, only 5 hours to clean 300 tubes, and only in the most extreme cases would a time corresponding to that given in the previous article be required. In some extreme cases it has been impossible to loosen the scale except by resorting to the use of a hammer.

\*Address: Fellows Gear Shaper Co., Springfield, Vt.



**A FRIENDLY VIEW OF THE HOBBING  
PROCESS**

By J. E.

A great deal has been published of late concerning the bad points of the hobbing process in its relation to the production of spur gears. The methods of dealing with the question have varied, but have in the main been along a similar line—that of an extreme case—and the authors have neglected to consider practical conditions before drawing their conclusions, thus leaving wrong impressions. To one who has made a study of the hobbing process under practical conditions, this misleading information stands without solid foundation and should be vigorously contradicted.

The hobbing process is one of the methods for producing spur gears, which is theoretically correct, and which like all other processes of the kind, must be modified to a certain degree to place it on a practical basis. These modifications must necessarily be made with care, and a thorough knowledge of the principles involved is required. Such modifications are not, however, limited to the hobbing process, but are common to all processes of generating interchangeable gearing of the involute system. It is not necessary to mention them here, as they are well known to those interested in toothed gearing. Of the many articles that have appeared on this subject, probably that which has caused the most commotion is the one by Mr. R. E. Flanders entitled "Ins and Outs of Gear Hobbing," which appeared in the January number of MACHINERY, and it is in answer to his article that this is written.

To one who has seen and cut gears for a variety of purposes, from those used for automobiles to those for cream separators, which in every case are giving as good satisfaction as a commercial product can well be expected to give, the statements set forth as facts in the article referred to would seem to require no further comment, were it not for the fact that many will accept them as true conditions. The first point that is brought up is the mysterious "hooked" tooth. Did anyone ever see or hear of a pair of gears that would run with exactly the same action when reversed on one another? The statement is ventured here that such a pair of gears has yet to be made. They are certainly not produced under any system of generating or cutting in general use. Mr. Flanders advances the theory that hooked teeth are caused by the "long complicated mechanism by means of which the movements of hob and blank are connected." He also alludes in his summary to this handicap of the hobbing machine which, he claims, is due to a fundamental fault in its design.

Have we a gear generating machine that has as direct connection and simple mechanism as this same hobbing machine? It has no reciprocating slides, no rocking shafts, no intermediate indexing mechanism, no cutter-withdrawing or clapper-box arrangement, none of which is absent in machines working on the principles of any of the generating systems. On the contrary, the motion of the gear-hobbing machine is continuous and uniform.

The fact that the machine which Mr. Flanders used in his tests was not properly adjusted accounts for the conditions found in the case of Blank 1, as it is well known that a milling cutter of the hob type will not give good results unless the slides and work are well supported and free from "looseness." An unfair comparison is also made with the Fellows gear shaper, leaving one to assume that this machine will produce gears that are perfect; but the gears cut on this machine are not put through the same tests as are tabulated in the table accompanying Fig. 8. The matter of looseness and play in the mechanism of the machine used in the tests should not be taken as a serious defect of the hobbing principle, but as a defect in that particular case, which could be corrected by proper adjustment or by proper care in design.

In regard to the hob, it may be said that the distortion due to hardening, is so small, when the tool is properly made and handled, as to be negligible, and no reputable manufacturer of hobs would send out one that showed distortion affecting in any serious degree the accuracy of the gear. Each

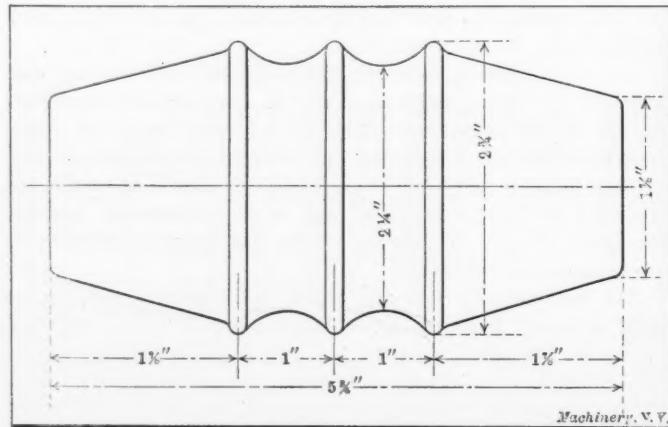
tooth has but a very small effect on the shape of the tooth generated, and since any distortion must be very small, we need fear little from this source. Possibly the cases Mr. Flanders cites relate to home-made hobs, which is not a proper condition on which to base conclusions. When made under proper conditions, by men experienced in the manufacture and treatment, the spur gear hob as made to-day needs no apologies. The interference of warped surfaces which need to be exaggerated in order to be noticeable even in extreme cases, is not a condition that is encountered in hobs used for cutting spur gears, as in no case is the angle greater than 10 degrees.

It will probably be of interest to Mr. Flanders to know that hobs made with straight flutes are made with a thread section that will produce the correct tooth form, and not with the same section that is used when they are fluted helically. It should also be noted that the standard makes of hobs have provision for the correction necessary for tooth interference and under-cutting. The fact that it is possible to produce good commercial gears from solid stock by one cut and at a rate that no other machine has yet equalled is the evidence that will decide whether the hobbing machine is to be delegated to the scrap pile or not. All conditions other than those referred to by the writer mentioned, point to the time (if it has not already arrived) when, for spur and spiral gears, the hobbing machine will be accepted by those who are at present doubtful about its making as good a showing as is claimed for the Bilgram and Gleason generators and the Fellows gear shaper. If we examine any process with the idea of picking flaws, we can generally find them. The writer has had the good fortune of having designed machines of both types, and knows from close study the faulty points as well as the good ones, and has found similar conditions with any machine, based on any principle.

\* \* \*

#### LUCAS BABBITT HAMMER

Until lately the common form of babbitt hammer with handle was provided in the shop of the Lucas Machine Tool Co., Cleveland, Ohio, for use wherever a babbitt hammer should be used as a driver to avoid bruising finished work. When Mr. Lucas saw one of his men using a babbitt hammer head without a handle he promptly asked the reason—a habit he has whenever anything out of common comes to his attention in the shop—and was told that the men generally preferred the babbitt hammers without handles for most uses. A mold



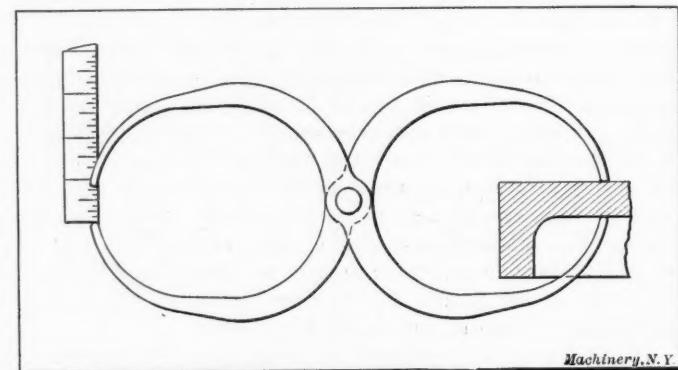
Lucas Babbitt Hammer

was made for casting a babbitt slug of the form shown in the illustration. The slug weighs about nine pounds, and is tapered at the ends to counteract in a measure the mushrooming action and thus prolong its effective life. The principal feature of novelty is the two finger grooves about the middle. These give a good hold where the slug balances in the hand. If one end is used more than the other the mushrooming throws it out of balance and so the grooves tend to make the men use both ends alike in order to keep the slug in good balance. The cost of handles is saved and the change is otherwise an improvement generally appreciated in this shop.

#### CALIPERING OVER A FLANGE

By GEORGE W. BURLEY\*

In some of the recent issues of MACHINERY several methods of measuring the thickness of a web behind a flange by means of ordinary outside calipers have been given. There is one method, however, which has not been dealt with, and which, in the opinion of the writer, is equal to any of those which have already been considered. This involves the use of a pair of double-ended calipers, as shown in the accompanying illustration. The two ends of the calipers are made exactly alike and the four points are therefore all at the same distance from the center of the joint. To give accurate results the points should just touch when the calipers are closed.



Method of Caliper Over a Flange

The method of using the tool is as follows: The legs of either end are placed over the flange and set down so that they bear lightly on the two sides of the web. The distance between the leg points at the other end is then obtained by taking a measurement with an ordinary rule, as indicated in the engraving. This distance is also the distance between the leg points at the end behind the flange, and, consequently, the thickness of the web. Thus, by the use of calipers of this kind, a single measurement only has to be taken, and there is no need of punch dots, packing or blocking, or screw adjustments.

#### OUTFIT FOR TESTING TOOL STEEL

In order to test the cutting qualities of various grades of tool steel, the O. K. Tool Holder Co., of Shelton, Conn., has fitted up a heavy-duty lathe for the purpose of ascertaining the power and time required for taking various kinds of cuts with tool steels of different brands. The testing outfit consists of a geared-head motor-driven lathe, the power required being read off on a watt-meter. The tests have been conducted especially to ascertain the qualities of the steel used in the tool-holders made by the company, which steel is imported from England.

So far, the tests have been made with the tools held in the  $\frac{5}{8}$  by  $1\frac{1}{4}$ -inch holder, and as much as 25 H. P. has been consumed for cuts taken with a single-point cutter in some of the tests. The cutting speeds and feeds used in these tests are of interest. Nickel steel (3 1/2 per cent) containing 0.40 per cent carbon was reduced 1 inch in diameter with a cutting speed of 75 feet per minute, and a feed of 0.025 inch. Cast iron has been cut with a speed of 165 feet per minute and 0.1 inch feed, reducing the diameter  $9/16$  inch; in one case 10 pounds of metal was removed in one minute. A cut 15 inches long, with a cutting speed of 175 feet per minute, was taken in three minutes on a bar of machine steel  $3\frac{3}{4}$  inches in diameter. During the three minutes 16 pounds of metal was removed; that is, at a rate of  $5\frac{1}{3}$  pounds per minute. In one case a piece was finished at a cutting speed of 385 feet per minute, removing  $1/16$  inch of stock, the length of time to cover 15 inches along the work being one minute.

In addition to the watt-meter giving the exact power consumed at all times, a device for indicating the speed of the cut and a scale for weighing the chips removed are included in the testing outfit.

\*Address: University of Sheffield, St. George's Square, Sheffield, England.

# NEW MACHINERY AND TOOLS

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP

Comprising the description and illustration of new designs and improvements in American metal-working machinery and tools, published without expense to the manufacturer, and forming the most complete record of new tool developments for the previous month

## ROCKFORD VERTICAL MILLING MACHINE

A design of vertical milling machine which is an interesting example of modern construction, has recently been brought out by the Rockford Machine Tool Co., Rockford, Ill. This ma-

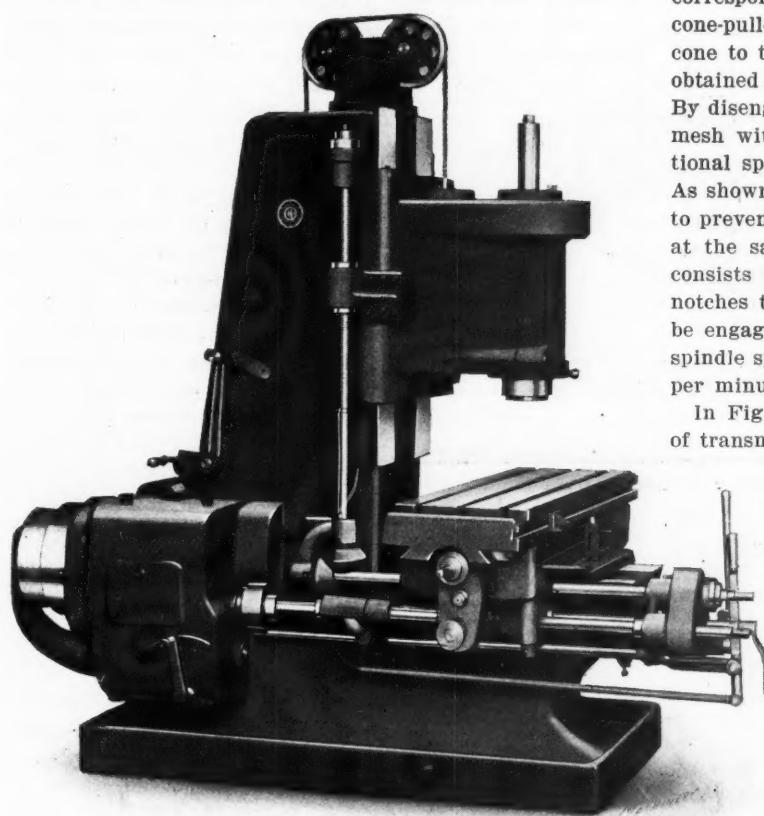


Fig. 1. Vertical Milling Machine, built by the Rockford Machine Tool Co.

chine, shown in the accompanying views Figs. 1 and 2, is of the type having a compound table rigidly supported on a horizontal slide or extension cast integral with the column. With this construction, the table is not adjustable vertically, as with a machine of the column-and-knee type, and of corresponding head have a vertical adjustment on the column and are counterbalanced to relieve the bearing of uneven strains. This bearing on the column is fully as large as that of the knee on a machine of the column-and-knee type, and of corresponding size, while the weight of the head is much less. As the top of the table is 30 inches from the floor, or approximately the same height as a planer pattern, castings or other parts to be machined, can be conveniently handled by the operator. This machine is provided with 12 speed variations for the spindle, and with 12 changes of feed, in either direction, for the table, saddle, and spindle-head. In addition, there is a rapid traverse for all feeding movements, which increases the general efficiency of the machine.

The drive to the spindle is from a three-step cone-pulley, attached to the rear of the column, as shown. Nine of the available speed changes are obtained through back-gears, and the remaining three are high speeds, with a direct drive, for use with small cutters. The method of obtaining the nine geared changes is indicated in Fig. 3, which is a longitudinal section of the column in a horizontal plane. On the shaft *A*, which connects through bevel gearing with the vertical spline shaft *B*, there is a sliding clutch *C*, the position of which is con-

trolled by hand lever *C*, Fig. 4. The vertical lever *D*, controls the position of the three sliding gears *D*, and when this lever and the gears are in a neutral position, a direct drive to the spindle may be obtained by the engagement of clutch *C* with a corresponding clutch cut on the end of the shaft carrying the cone-pulley. In this way a direct high-speed drive from the cone to the bevel gears connecting with the vertical shaft, is obtained with three variations from the steps on the cone. By disengaging clutch *C* and moving gears *D* successively into mesh with three corresponding gears on shaft *E*, three additional speed changes are obtained for each step on the cone. As shown in Fig. 4, the two levers *C* and *D*, are interlocking, to prevent any conflicting combination of gears being engaged at the same time. This locking device is very simple, and consists of a segment-shaped projection on lever *D*, having notches that engage the clutch lever, so that clutch *C* cannot be engaged unless gears *D* are in a neutral position. The 12 spindle speeds thus obtained, range from 13 to 200 revolutions per minute, in geometrical progression.

In Fig. 5, which is a cross-section of the head, the method of transmitting the power from the vertical spline shaft *B* to the spindle, is shown. The driving pinion is made from a steel forging, and the large gears from steel castings. The spindle gear is provided with large bearings, as shown, which relieve the spindle of all side strains. The spindle has a vertical adjustment of 6 inches, which is effected by the handwheel shown to the right in Fig. 2, the movement being transmitted through worm gearing to the pinion *F*, Fig. 5. The spindle is a crucible steel forging, and it is provided with adjustable taper bearings to compensate for wear.

The construction of the feed-changing mechanism is shown by the sectional view, Fig. 6. The

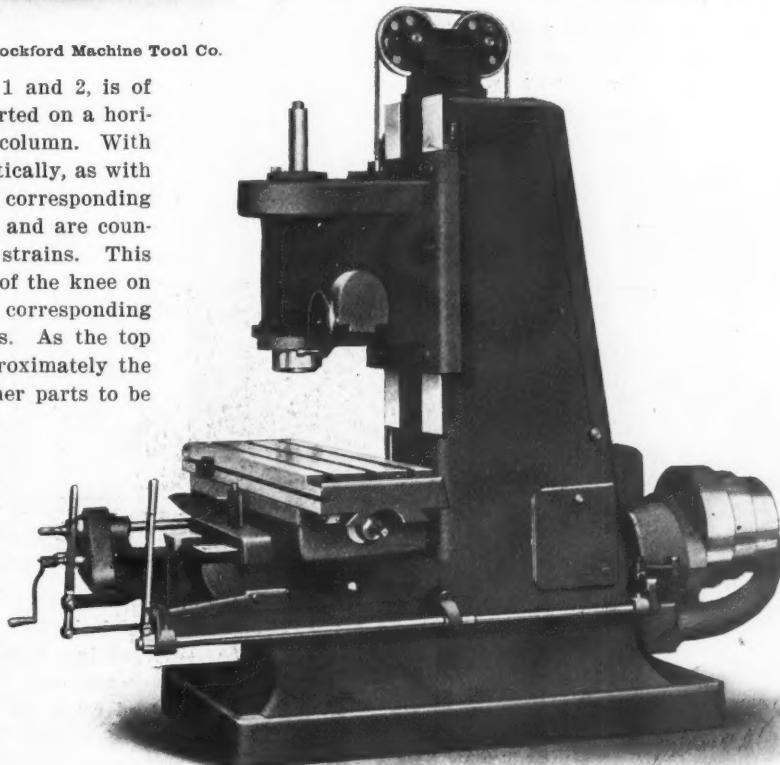


Fig. 2. Another View of the Rockford Milling Machine

drive to the feed-box is through a spur gear which meshes with a pinion on the back-gear shaft *E*, Fig. 3. The feeds are engaged and reversed by a clutch *G*, mounted on the upper

shaft, which is the highest-speeded shaft in the box. The lever for operating this clutch is conveniently placed in front of the machine, and connection is made as indicated in Fig. 1. The power from the clutch-shaft is transmitted through slip-gears *H* at the left. Two pairs of these gears are used, which are reversible, thus giving four changes. Three changes for each position of the slip-gears are obtained by the sliding

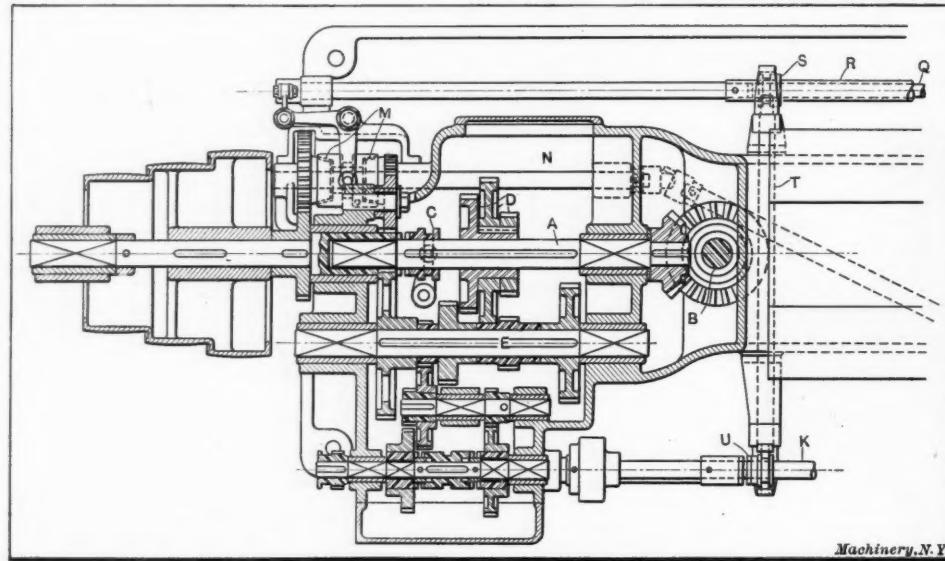


Fig. 3. Section through Column in Horizontal Plane, showing Change-gear Mechanism

gears *J* on the lower shaft. The position of gears *J* is controlled by the lever *J*, Fig. 4, and the changes are effected by engaging these gears with one of the three gears on the feed-shaft *K*. The twelve feeds thus obtained range from  $\frac{3}{4}$  inch to 17 inches per minute, and the feeding movement is transmitted from shaft *K* to the table, saddle, and the head, as desired. The friction coupling *L* on the feed-shaft will drive any feed, but it will not transmit sufficient power to break the feed gears or other parts, in case the saddle should be fed against the column, the table nut against the end of the saddle, or the feeding movement otherwise positively stopped by some rigid obstruction.

One of the noteworthy features of this machine is the rapid power traverse, which enables the table and head to be adjusted quickly to any desired position. The control and operation of this rapid traverse will be understood by referring to Figs. 2 and 3. The power is obtained direct from the cone-

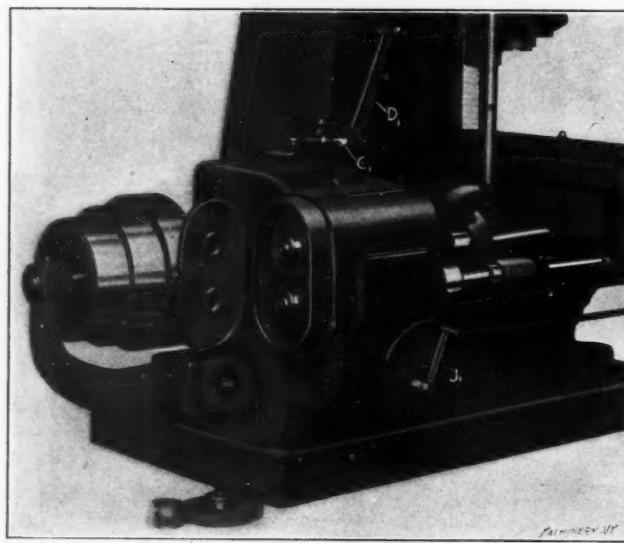


Fig. 4. Detail View showing Driving Cone, Feed Box and Speed and Feed Control Levers

shaft by spur gearing, and it is transmitted through a reversible clutch at *M* to shaft *N*, which connects through an angular shaft and universal joints to the feed train in front of the machine. The lever for controlling the position of reversing clutch *M*, and also that of clutch *U* on the feed-shaft, is conveniently placed in front of the machine on the right-hand

side, as shown in Fig. 2. This controlling lever has a very simple interlocking arrangement which makes it absolutely impossible for the feed mechanism and the rapid traverse to be engaged at the same time. With the lever in the position shown, the rapid-traverse clutch *M* is locked in a neutral position, and the clutch *U* of the feed-shaft is engaged. This lever is pivoted and has a lower projection engaging a rod *Q* which passes through hollow shaft *R* and connects with collar *S* by a key which extends through a slot in the hollow shaft. This sliding collar *S* is connected by a yoke with the cross-shaft *T* which, in turn, connects with clutch *U* on the feed-shaft. It will be seen that when the operating lever is moved outward, clutch *U* will be disengaged, and the lever, which in its inner position engages a slot in the supporting bracket, can be moved to the right or left, thus engaging the reversible clutch *M* and applying the rapid traverse. The direction of the traverse will, of course, depend upon whether the controlling lever is swung to the right or left. When it is desired to again connect the feed, this is accomplished by pushing the lever into engagement with the slot previously referred to, which can-

not be done without replacing traversing clutch *M* in a neutral position.

All movements of the table, saddle, head and sleeve are indicated by graduated collars reading to 0.001 inch, and the longitudinal and cross movements are equipped with automatic stops. All slides are fitted with taper gibbs that are adjustable endwise to compensate for wear. The saddle slide is double-

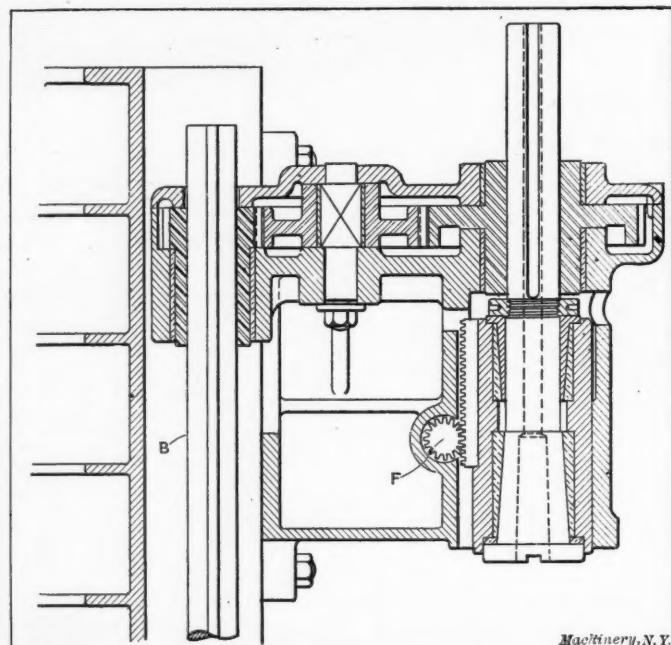


Fig. 5. Cross-section of Spindle and Head

gibbed, there being a taper gib on the inside of the right-hand bearing, thus insuring perfect alignment when feeding under heavy cuts. All shaft bearings are provided with wool-felt oil retainers, and there is also very efficient means for oiling the driving shafts and feed-box. All the bearings are connected by groups of soft brass tubes  $\frac{5}{16}$  inch in diameter, with oil cups having hinged covers. Two of these cups can be seen on top of the feed-box in Figs. 1 and 4.

The general dimensions of this machine are as follows: Distance from the center of spindle to column, 15 inches; maximum distance from table to spindle, 24 inches; minimum distance from table to spindle, 3 inches; diameter of spindle

at taper, 4 inches; diameter at upper end, 3 inches; working surface of table, 14½ by 48 inches; total length of table, 56 inches; feed to table, 32 inches; vertical movement of head on column, 21 inches; width and length of head bearing on column, 19 inches by 25½ inches; minimum and maximum

limit of the machine may be obtained without the necessity of shutting down the engine or throwing off the load.

The grip device consists essentially of a grooved steel disk *K*, keyed on the driven shaft *L*. A pair of grip-ring rocker-plates *E* are mounted on each side of the grooved disks and are free to oscillate on bosses. Near the rim of these rocker-plates are eight equidistant pins *M*.

These pins have square central portions, on which are mounted dogs or wedge-blocks *N*, these being held in place by plates *O*. The inner ends of these wedge-blocks are turned to an arc of a circle, whose radius is somewhat greater than their distance from the pin *M*, the reason for which will be explained. These dogs fit into the V of the grooved steel disk *K*, previously mentioned, having a line contact with it. In their normal position these dogs *N* are radial, and just touch the groove of *K*; but if they are swung slightly in either direction they will grip the latter, as the radius of their turned ends is greater than the point on which they are swung. The driven shaft can thus be revolved in either direction as desired, by swinging the wedge-blocks in the proper direction. This can be done without shutting down the machine, by

means of the shifter *Q* which engages with the crank-pin *R*, the latter, in turn, connecting through a crank to a segmental gear *S*, oscillating the shift-plate *T*. This shift-plate *T* has projections *U* which lie directly under collets *V* on the small pins *M*. The sidewise movement of the shifter *Q* thus swings the wedge-blocks in one direction or the other. This

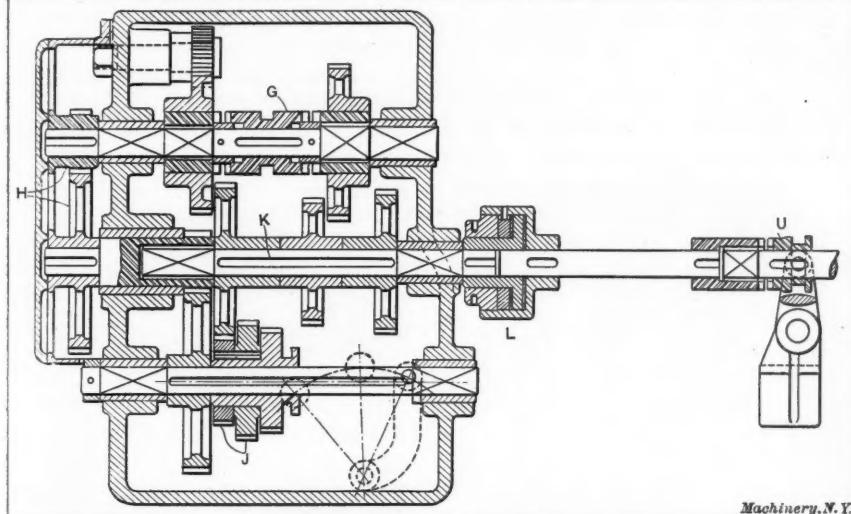


Fig. 6. Sectional View of Feed-box

diameters of steps on cone, 12 and 15½ inches, respectively; width of driving belt, 4 inches; and net weight of machine, 6800 pounds.

#### FELLOWS GEARLESS VARIABLE-SPEED TRANSMISSION

The Fellows Direct Power Transmission Co., Los Angeles, Cal., has recently placed on the market a unique type of gearless variable-speed transmission which is herewith illustrated and described. Fig. 1 gives a diagrammatic representation of this gear. The driving shaft *A*, which may be directly connected to the engine, has a crank *B* which rotates with the shaft and transmits the power through the connecting rod *C* to a lever *D*, and thence to the grip ring *E*, as will be explained.

A bell-crank *F* is attached at its lower end by a pin *G* to a fixed point on the machine, while at its angle it is connected through two levers *H*, to the before-mentioned lever *D*. This

shifting may take place without interrupting the oscillation of the rock-plates, as the grooved shifter permits a continuous movement of the pin *R*.

This type of transmission has been compared to that of a street car controlling mechanism to which it bears a very close analogy; the shift-block *Q* corresponds to the reverse lever of the controller, and the lever *I* corresponds to the various notches of the controller box.

In operation it is customary to use at least three of these transmissions mounted in a set, in order to secure absolute continuity of rotary movement. This is illustrated by the halftone, Fig. 2, which shows this form of transmission applied to gas engine operation in the oil fields, where it is claimed that the results have been very satisfactory. This type of transmission can take its power either from a constant-speed electric motor, or from any form of internal combustion engine, and the makers claim that it will deliver from 97 to 98 per cent of the power imparted to it.

This type of transmission has been successfully applied to gasoline railroad section cars. One particular car cited operates on seven horsepower, has all speeds in both directions, and can carry its load and haul trailers on any grade.

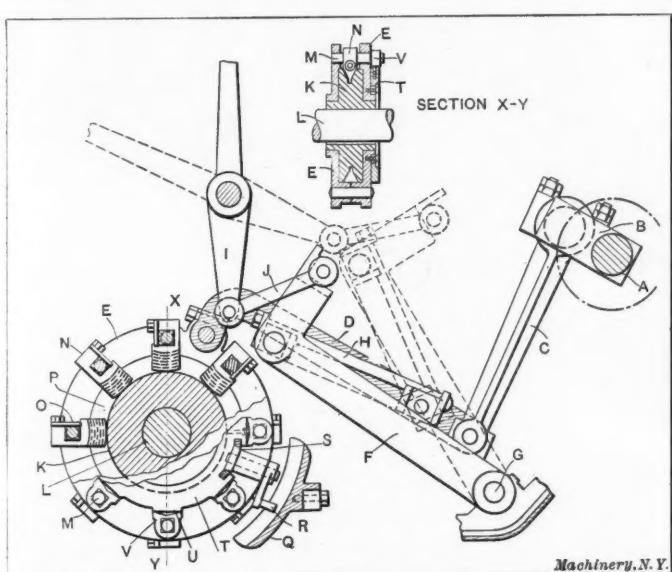


Fig. 1. Diagrammatic View of the Fellows Gearless Variable-speed Transmission

provides a toggle movement for the reciprocating connecting rod *C*, giving a varying amount of oscillation to the grip ring *E*, depending upon the location of the bell-crank *F*. This latter may be shifted, as shown by the dotted lines, by means of the lever *I* connecting with *E* through the link *J*. By proper adjustment of this lever *I*, any oscillation from zero up to the

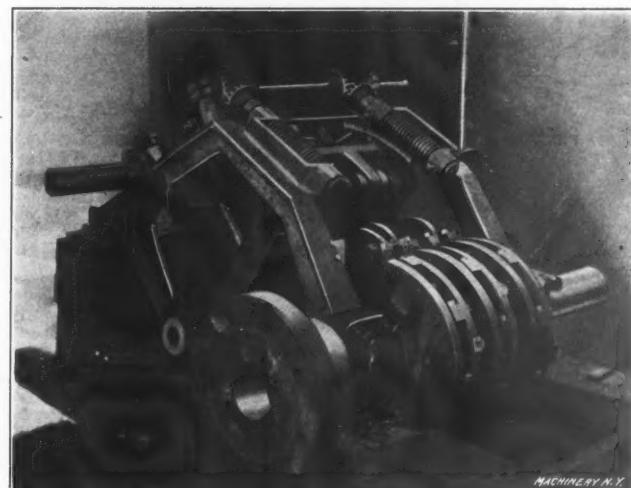


Fig. 2. A Fellows Gearless Variable-speed Transmission as applied to a Gas Engine in the Oil Fields

### LARGE DUPLEX VERTICAL MILLING MACHINE

A large duplex type of vertical milling machine has recently been designed and built by the Newton Machine Tool Works, Inc., 24th and Vine Sts., Philadelphia, Pa., especially for the McClintic-Marshall Construction Co., to be used in milling the faces on the gates for the Panama Canal. This machine, a view of which is shown in Fig. 1, is also arranged to handle large structural work, etc. It is equipped with two columns, each of which is independently driven by a 20-horsepower motor having a speed ranging from 450 to 1350 revolutions per

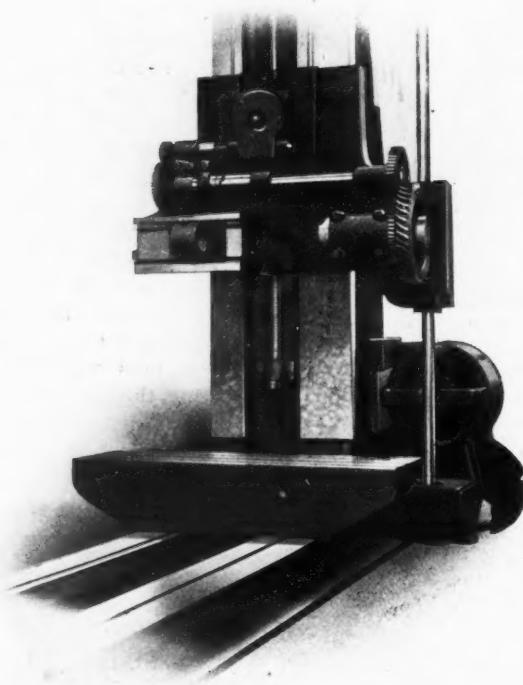


Fig. 2. Detail showing Drive to Spindle and Feed Mechanism

minute. The motion is transmitted from the motor through a pinion and intermediate gear to the large driving gear mounted on a horizontal shaft at the side of the upright near the base. This horizontal shaft connects through bevel gearing with a vertical spline shaft which drives the spindle through worm gearing, as shown more clearly in the detailed view Fig. 2.

The worm-wheel is equipped with a bronze ring, and the driving worm is of hardened steel. Both the wheel and the worm are encased for continual lubrication, and the latter is fitted with roller thrust bearings. The bearings for both the worm and wheel are cast solid with the saddle. The spindle of this machine is  $6\frac{1}{8}$  inches in diameter; it is fitted with a No. 7 Morse taper and revolves in a bronze-bushed capped bearing. As the engraving shows, an outboard bearing is provided which has a transverse adjustment. This bearing is fitted with a taper bushing which is cylindrical on the inside and has a taper external bearing with adjusting nuts, to compensate for any wear which may occur.

The spindle saddle has square lock-gibbed bearings on the upright, and the adjustments for alignment are on one shear of the column face. The saddle is counterweighted as shown, and it has a fast vertical adjustment actuated by power and controlled by a conveniently located lever. The power for this traverse is obtained from the vertical spline shaft, which extends to the top of the column as shown, and connects, by means of a horizontal shaft, with a lead-screw located in the

center of the column. A reverse movement for the rapid traverse of the saddle is obtained by a double train of bevel gears which connects the vertical spline shaft with the intermediate horizontal shaft at the top of the column. Interposed between these gears there is a Carlyle-Johnson friction clutch, by means of which engagement for upward or downward movement of the saddle is obtained.

The drive for the feed motion is taken directly from the cutter spindle, which carries a large spur gear just inside the driving worm-wheel, meshing with a second spur gear which is mounted on the horizontal shaft seen extending across the saddle in Fig. 2. This shaft connects, in turn, through change gears, with another horizontal shaft just above it that transmits the feeding movement to a nut revolving about the vertical lead-screw. This lead-screw remains stationary except when the rapid traverse is engaged, and it has a top and bottom bearing to permit of its always being maintained in tension. With this construction only one feed is available at a time, but a sufficient number of change gears is furnished to give feeds ranging from 0.035 to 0.321 inch per revolution of the spindle. The engagement or disengagement of the feed is effected by a clutch, as shown, which is controlled by a lever located just back of the saddle.

This machine has a capacity for cutters having a maximum

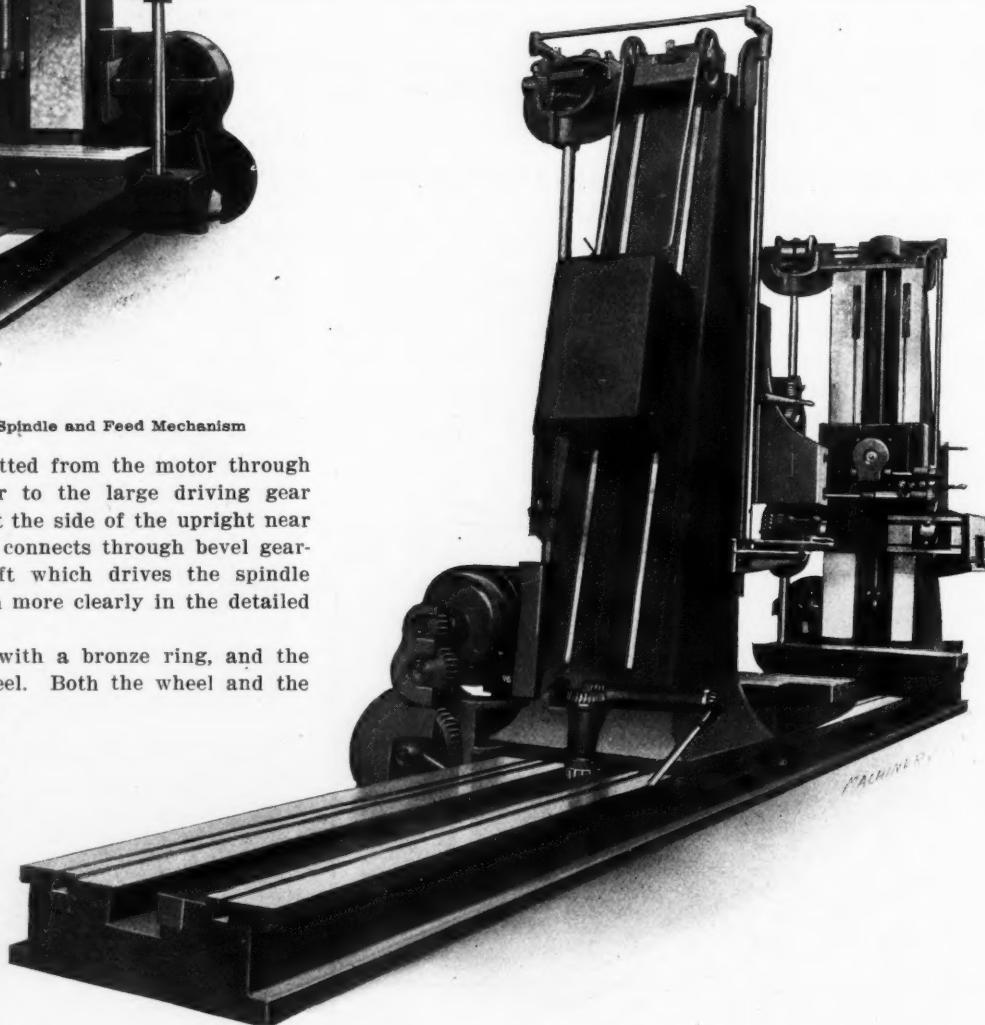


Fig. 1. Large Vertical Milling Machine built by the Newton Machine Tool Works, Inc.

diameter of 13 inches and a length of  $39\frac{1}{4}$  inches, while the minimum capacity for length is  $25\frac{1}{4}$  inches. The minimum distance from the work support to the center of the spindle is  $10\frac{1}{2}$  inches, and the maximum distance is 8 feet,  $4\frac{1}{2}$  inches. A base for supporting the work is attached to each column and the columns each have 12 feet of hand adjustment on the bed. The bed is made in three sections, the intention being to mount one upright on each end-section, with the intermediate section between them, when an extension is necessary for especially long work. This machine is also manufactured in smaller sizes to meet ordinary requirements.

### ROCKFORD UNIVERSAL JIG AND THREE-SPINDLE TAPPING MACHINE

The universal jig illustrated by the three accompanying views is an interesting design, built by the Rockford Drilling Machine Co., Rockford, Ill., to meet the special requirements of a customer. As the casting for which the jig was designed required tapping operations on every side, it was necessary to so construct the jig that the work could be quickly placed in the various positions.

To obtain a universal adjustment, the double-trunnion type of construction was employed, the work being attached to a

using supporting blocks, and it can be quickly and accurately adjusted to different positions with little effort on the part of the workmen.

When the casting is placed in the jig, it remains in the same position with relation to the inner work-holding bracket, until all the operations are completed. This jig is mounted on four casters, each of which is equipped with a ball-bearing to minimize the friction, so that the jig and work can be readily moved to any desired position beneath the drill spindles.

A three-spindle, combined drilling and tapping machine that is a special design built by the Rockford Drilling Machine Co. for use in conjunction with the universal jig, is shown in Fig.

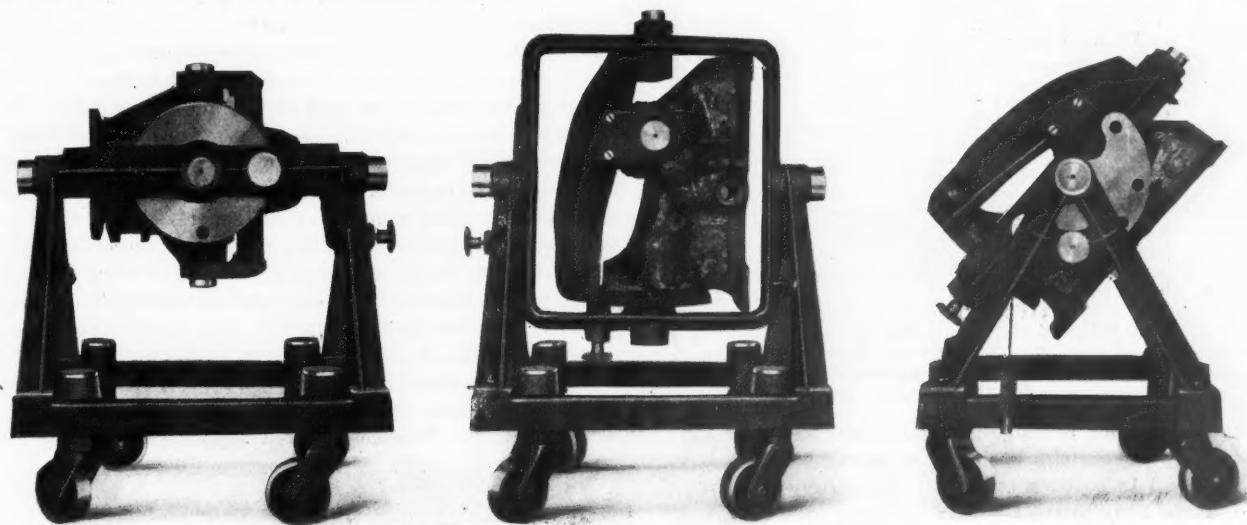


Fig. 1. Jig with Universal Adjustment, built by the Rockford Drilling Machine Co.

bracket mounted on trunnions in an outer frame that, in turn, has trunnions in the supporting stand. As the three illustrations indicate, this construction enables the work to be placed in any required position. To positively and quickly locate the casting for tapping the different holes at the correct angles, each of the swiveling frames is provided with an indexing

2. As will be noted, the heads with which this machine is equipped differ considerably in size, thus enabling a variety of tapping operations to be performed. The heads are all provided with the makers' tapping attachment, and they are similar in construction to those used on the regular 14-inch, 20-inch back-gear, and 23-inch back-gear drilling machines built by this company. This machine is equipped with a special base, upon which the jig and its work is mounted. It has a tapping capacity ranging from  $3/16$  to  $1\frac{1}{4}$  inch.

### WOOD & SPENCER STANDARD DRILLING AND REAMING JIG

A standard drilling and reaming jig, designed for handling a wide range of work, has been placed on the market by the Wood & Spencer Co., of Cleveland, O. This jig is so designed

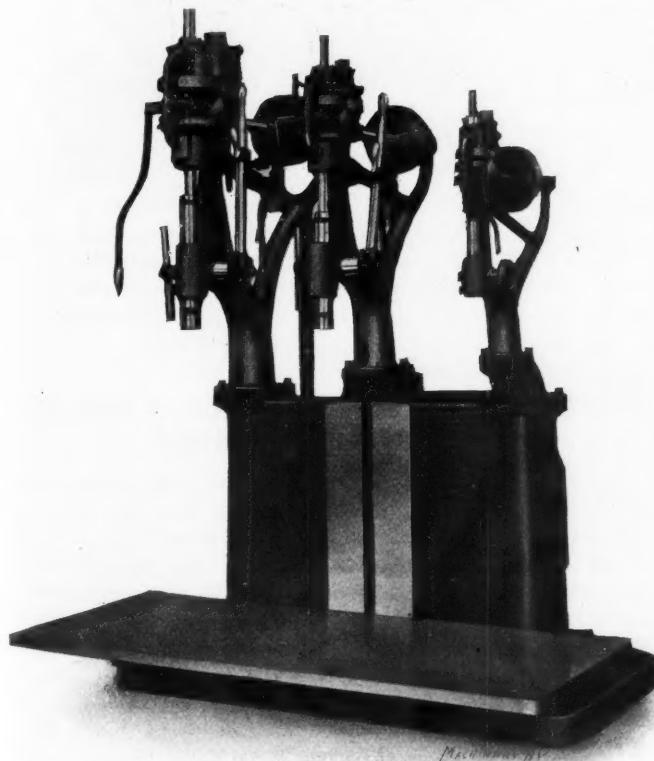


Fig. 2. Special Three-spindle Tapping Machine

plate containing as many holes as are needed for locating the work in the different positions required. These holes are engaged by indexing pins, one of which is in the outer frame and the other in the supporting stand. In this way the casting is held for the various operations, without the necessity of

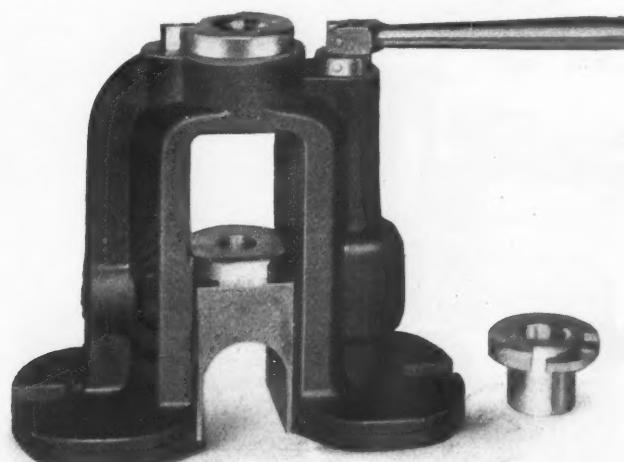


Fig. 1. Standard Drilling and Reaming Jig designed for Handling a Wide Range of Work

that it may be quickly operated for clamping or releasing the part being machined. It is equipped with a lower sliding member that serves to clamp the work by holding it against the top part of the jig. This sliding member is actuated by a hand lever that is connected to a shaft on which is mounted a double-threaded worm, as shown in the sectional view, Fig.

2. The worm engages teeth cut in the side of the sliding member, and being double-threaded, gives a rapid adjustment.

The average piece to be drilled can be fastened or released by a quarter-turn of the clamping lever. As this lever is free to swivel on its shaft, it can readily be placed in the most convenient position. For comparatively large jigs, a single-threaded worm is used in order to obtain greater clamping power. The liner bushing *A* is shaped on its under side to suit the work, but the bore of this bushing is kept standard, so as

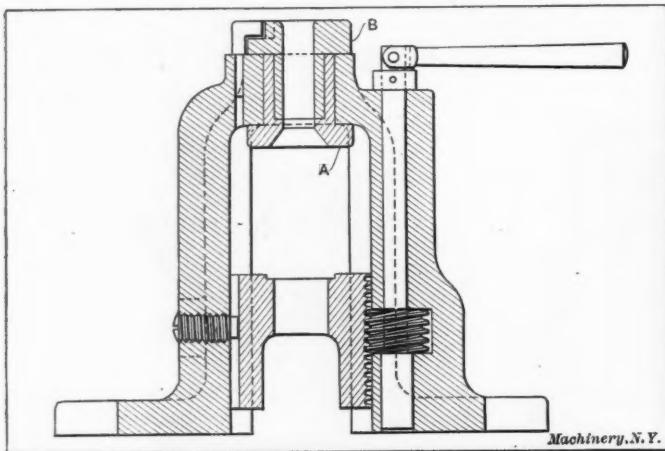


Fig. 2. Sectional View of Wood & Spencer Jig

to interchange with all the slip bushings that belong to any given size of jig. These slip bushings, as shown more clearly in Fig. 1, are held in position by what is practically a bayonet lock, there being a pin in the jig body having a projecting end that engages a half-flange on the bushing. The sliding member contains a regular bushing as shown, or it can be equipped with work-holding blocks of special shape when necessary. These jigs are made in eight sizes and lengths, and are furnished with or without bushings.

#### STEPTOE CRANK-SHAPER WITH SPEED-BOX AND MOTOR-DRIVE

The John Steptoe Shaper Co., of Cincinnati, O., is now building the crank-shaper illustrated in Fig. 1, which is equipped with a self-contained motor-drive and a speed box for giving the necessary speed variations. The motor used is a 3-horse-

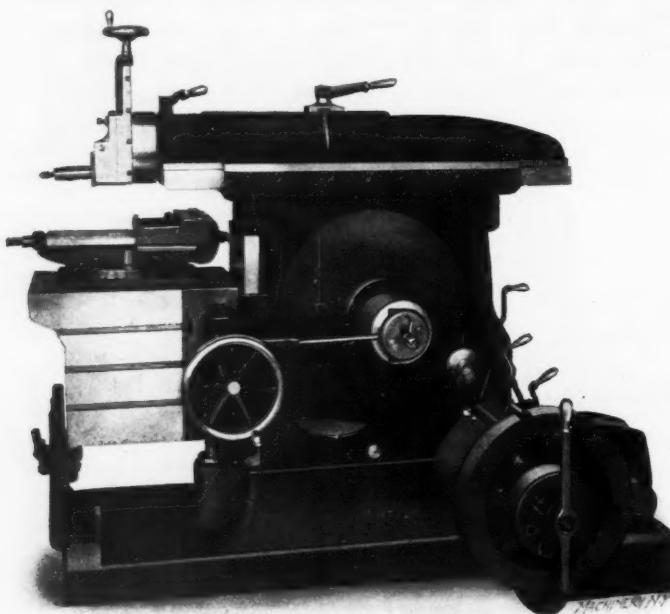


Fig. 1. Twenty-four-inch Motor-driven Back-geared Crank-shaper, with Speed-box

power constant-speed type, having a speed of about 1200 revolutions per minute. The drive from the motor to the speed box is through a small pinion on the motor shaft, which meshes with a large gear on the speed box shaft. Four

changes of speed are obtained in the speed box and this number is doubled by the back-gears, giving eight changes in all. The machine can be started or stopped by means of a clutch which operates in the hub of the large gear. This clutch can be operated with little effort on the part of the workman, as one-pound pressure on the clutch lever gives 128-pounds pressure on the ring.

The gears and the clutch mechanism are fully enclosed by guards as shown, thus avoiding the possibility of accidents. All the bearings in the speed boxes are equipped with ring oilers which keep the shafts constantly flooded with lubricant. The proper distribution of the oil over the entire bearing is insured by spiral oil channels in the shafts. The speed box is so designed that no clutches are used, and there are no gears running idle on the shafts. The arrangement is such that when one gear is shifted into position the other is shifted out, so that the wear is reduced to a minimum and all unnecessary noise eliminated. All gears are keyed to their shafts and they are only subjected to wear when in actual operation.

Where the driving shaft from the shaper enters the speed box, a large bushing is provided which enters the column of the shaper and also the speed box bearing. The advantage of this construction is that any strain that might come from the speed box is taken directly by the bushing and not by the driving shaft. This bushing is provided with ring oilers, both in the column of the shaper and in the speed box. The intermediate shaft in the shaper is also provided with ring oilers which can be readily removed or replaced at any time should this be necessary. The speed box is supported by means of a

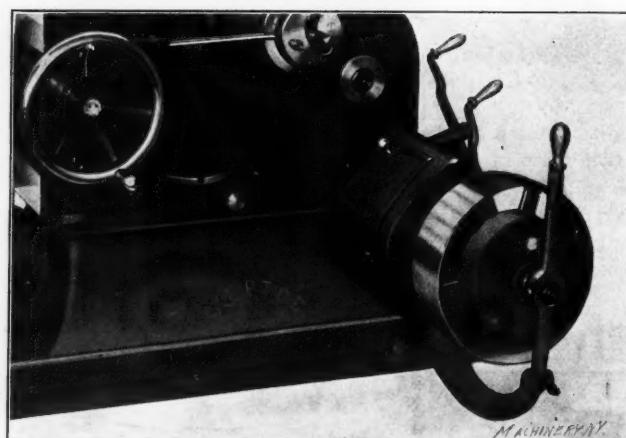


Fig. 2. Back-geared Crank-shaper with Speed-box and Clutch Pulley

heavy brace that projects from the base of the shaper. The motor is set on a sub-base which is cast integral with the base. This construction gives the motor a very solid foundation and eliminates any vibration when the machine is running, thereby preventing chatter marks on the work which is being planed.

#### ROCKFORD SPECIAL DRILLING, TAPPING AND TURNING MACHINE

A special machine by means of which the pump stand casting of an ordinary agricultural force pump may be finished at one setting of the work has recently been built by the Rockford Drilling Machine Co., Rockford, Ill. The casting is illustrated in Fig. 2, which also indicates the operations required. There are fourteen operations in all, including drilling, boring, facing and tapping or threading. Formerly this work was done, principally, in the upright drill press. The castings are now placed, as they come from the tumbling mill, in this special machine which finishes them ready for the paint shop and assembling floor. The time required for the completion of the fourteen operations indicated in Fig. 2, is about five minutes per casting, whereas the time required by the method of machining formerly employed varied from 40 to 50 minutes per casting.

This machine is driven by three belts operating on pulleys *A*, *B* and *C*, from which the power is transmitted through gearing and shafts to the various spindles. Each spindle is

provided with suitable clutches so that it can be immediately disengaged when the operation for which it is intended is performed. Automatic knockouts are also provided for the feeds wherever necessary.

The function of the various parts is as follows: The multi-spindle head *D* is for drilling four holes in the base *d*, Fig. 2; the square bar *E*, driven by the right main spindle, is for tapping the internal hole *e*; the auxiliary head *F*, at the front, is for drilling and tapping the two holes in boss *f*; the left spindle *G* is for boring, facing, and threading end *g*; the angle and vertical spindles *H* are for drilling and tapping holes *h*; and the hole *i* in the casting is drilled and tapped by a spindle in the rear that is not shown in the illustration.

One of the interesting features of the machine is the 4-spindle auxiliary-head *D* located in front of the right main spindle. The adjustment of the spindles on this head is controlled by the small hand lever seen at the top. By moving this handle forward or backward, the diameter of the circle in which the holes are drilled, is increased or diminished, the construction making it possible to secure an instantaneous adjustment of the four spindles. This head is driven through gearing from shaft *I* which, in turn, is rotated by a belt operating on pulley *C*. The feeding mechanism for head *D* is located at *K* and derives its power through a chain drive and gearing, as shown.

Shaft *I*, in addition to driving drilling head *D*, transmits power to the angle and vertical spindles *H*, through bevel gear-

ment of this back spindle is controlled by shifter *O* which connects with a friction clutch, and the spindle is adjusted by a handwheel. The angle and vertical spindles are also adjustable along their supporting base, the adjustment being effected by means of the handwheel and screw shown.

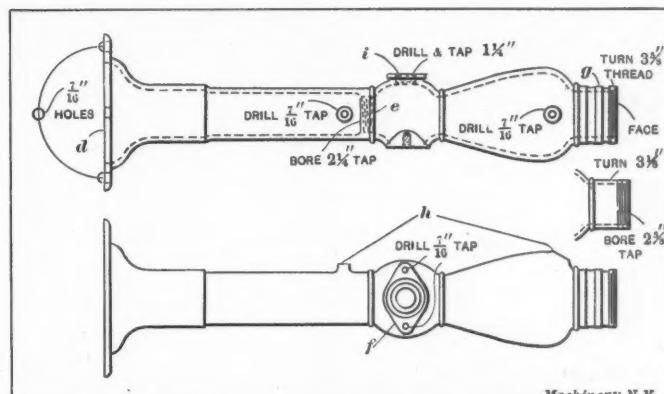


Fig. 2. Pump Casting upon which Fourteen Operations are performed in Special Machine shown in Fig. 1

The pump casting is held, while being machined, in a fixture of simple design, in which it may be quickly clamped or released. As will be seen, the entire control of the machine is from the front, and the various spindles have sufficient adjustment to permit the machining of the different sizes of

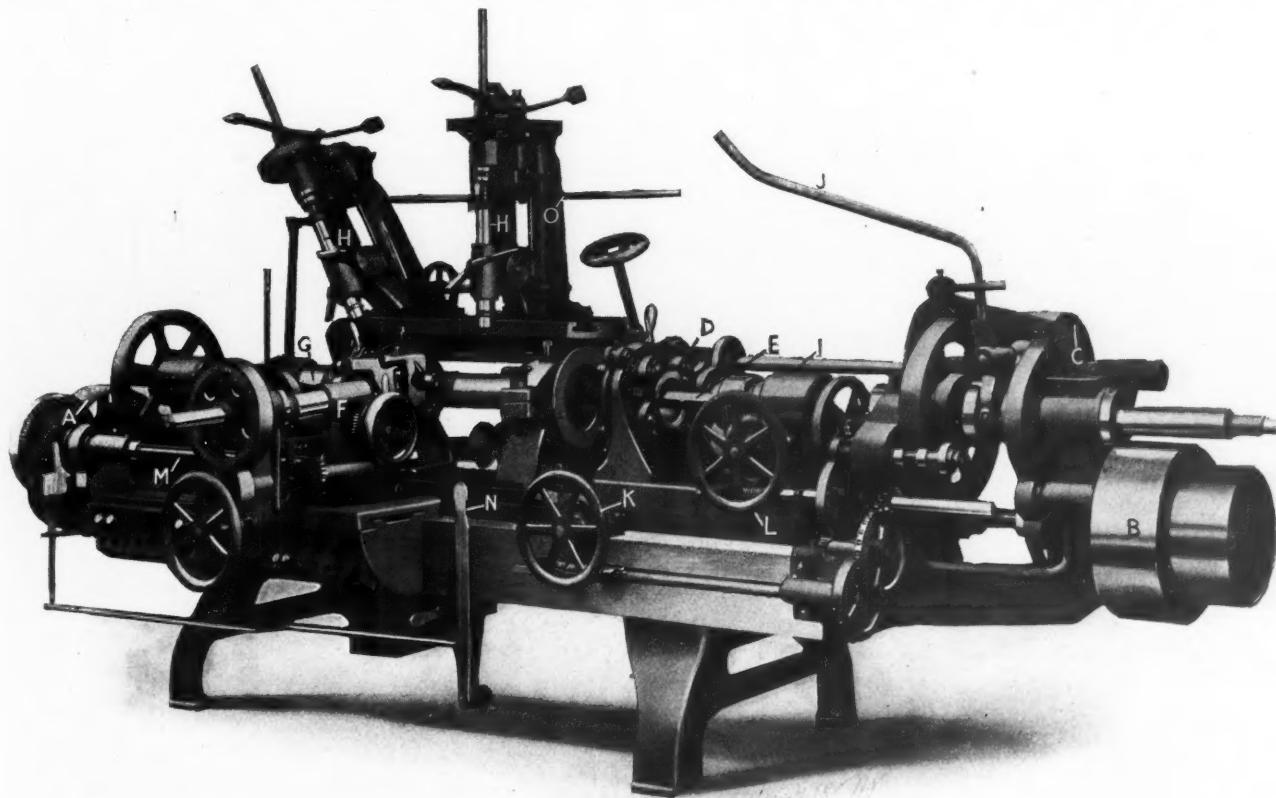


Fig. 1. Special Machine for Machining Force Pump Casting shown in Fig. 2

ing. The square tapping-bar *E* is driven by the right-hand spindle, and it is reversed when withdrawing a tap, by engaging a clutch, controlled by handle *J*, with a reverse gear on the right. The feeding mechanism for tapping-bar *E* is located at *L* and is driven through gearing from the right spindle. The drive for spindle head *F*, to which is attached a 2-spindle auxiliary head for drilling and tapping the holes in boss *f*, Fig. 2, is transmitted from the left-hand driving pulley *A* through a train of gearing and shaft *M* which may be disconnected from the driving train by operating a clutch controlled by lever *N*. This head is mounted on a dovetailed slide, and it can be adjusted longitudinally when necessary. The left-hand spindle for performing the tapping, boring, and facing operations on end *g* of the casting is driven through gearing by pulley *A*. This pulley also drives the back spindle, previously referred to, which is for machining hole *i*. The move-

castings required for the line of pumps made by the concern for whom the machine was constructed.

#### HARRINGTON 16-32-INCH EXTENSION LATHE

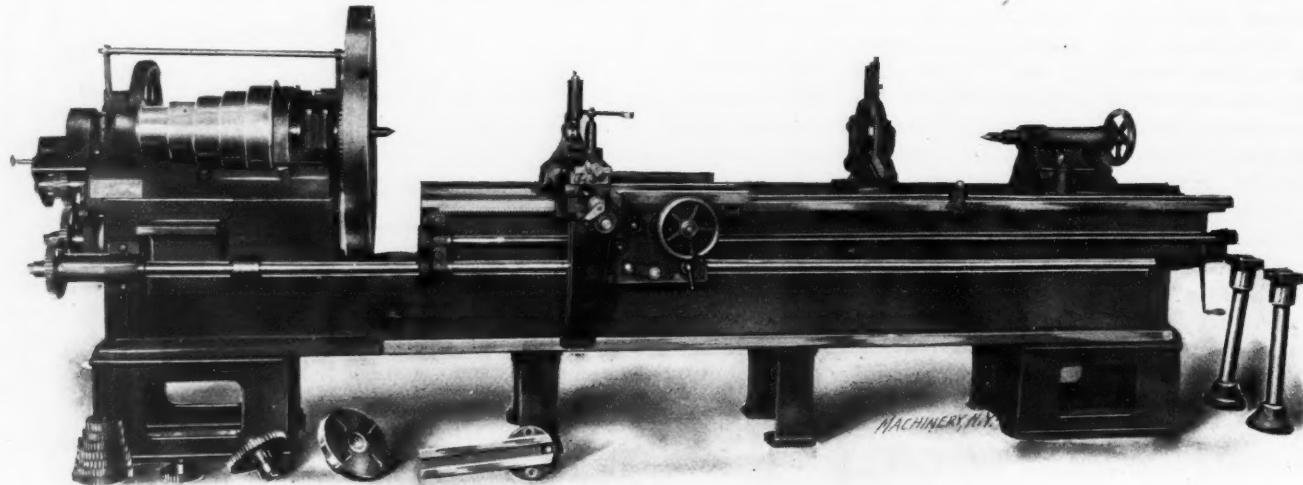
Edwin Harrington, Son & Co., Inc., Philadelphia, Pa., have brought out a new size and design of high-duty extension lathe, which is shown in the accompanying halftone. All the general features common to the extension lathes regularly built by this company have been retained, and, in addition, provision has been made for the application of a taper attachment, a quick-change gear-box, and a motor-drive, if such equipment is not ordered originally.

The extension and main beds of this lathe are very wide, securely braced and carefully fitted. The upper bed is ad-

justed by a screw that is operated from the end of the lathe, and it is supported, when extended, by two jack-screws, in addition to the regular clamping bolts. The headstock is equipped with triple gearing that gives ample power for turning work of large diameter. The spindle is of forged high-carbon steel, and it has large bearings in phosphor-bronze boxes. Feed and screw gears are provided for cutting all regular threads, and when the machine is equipped with an ordinary swing yoke, three changes of feed are obtained by operating a sliding clutch-pin. When a quick-change gear-box is attached, all threads and feeds are obtained by operating

tudinal and cross movements of the work table are provided, which are conveniently controlled by the workmen.

By referring to the illustrations, it will be seen that the work table or platen is mounted on a large base which is made in two sections that are joined by angular ways. Obviously, with this construction, any movement of the upper section will result in a vertical adjustment of the table. This movement is effected by an angular screw, the squared end of which is seen projecting from the front. When the table is positioned vertically in this manner, the two members of its supporting base are rigidly locked by six bolts which



Sixteen—Thirty-two-inch Extension Lathe, built by Edwin Harrington, Son & Co., Inc.

one lever and a clutch-pin. Gears for cutting metric threads can be provided with either the swing yoke or gear box. All regular threads from 2 to 28 per inch, including the 11½ per inch pipe thread, can be cut.

The carriage has long bearings on the bed, and the cross-slide is provided with an extension for turning large diameters, which is rigidly supported by a bracket, as shown, having an adjustable shoe or guide on the lower edge of the bed. An extension toolpost is furnished, to replace the compound rest for turning across the gap. The apron has a geared friction feed operating the longitudinal and cross feeds. The feed is reversed at the apron and it has a positive interlocking device to prevent engaging the screw nut and feed simultaneously.

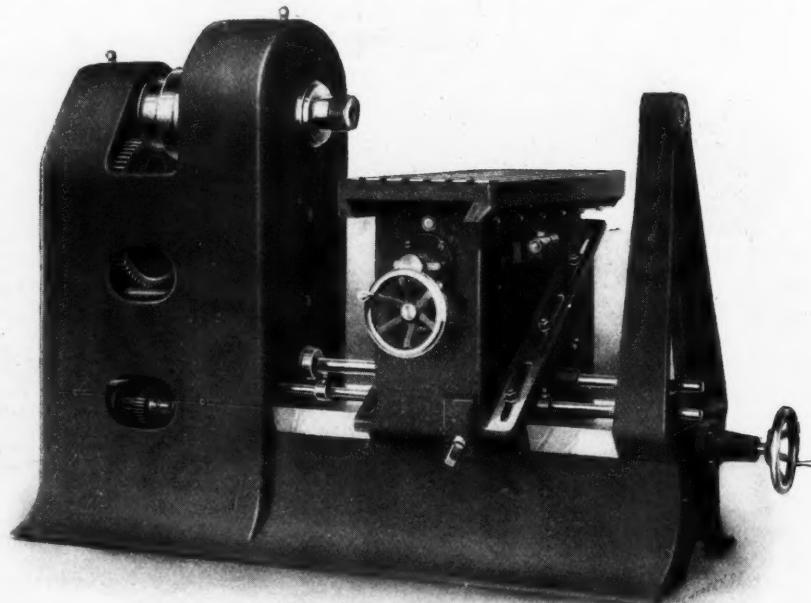
When a motor drive is employed, the motor is mounted on the headstock and engages gears which replace the cone. The motor speed control is governed by a handwheel on the apron. The taper attachment is connected to the back of the carriage, and does not require special lugs cast on the bed.

The principal dimensions of this lathe are as follows: Swing over the top shears, 16 inches; swing over the lower guides, 32 inches; swing over the carriage, 11 inches; ratio of back gearing, 6.25; ratio of triple gearing, 25.6; feeds in turn per inch, 6.85 to 96; diameter of hole through spindle, 1 9/16 inch; length of bed (not extended), 8 feet 2 inches; distance between centers, bed closed, 4 feet; distance between centers, bed extended, 7 feet 3 inches; size front spindle bearing, 3 1/4 by 5 5/8 inches; size back bearing, 2 3/8 by 4 1/4 inches; weight, 4000 pounds; additional weight per foot of extra length, 325 pounds.

#### BURKE MACHINERY CO.'S FACING AND BORING MILL

The Burke Machinery Co., Conneaut, Ohio, is now building a machine of the type shown herewith, which is adapted to both milling and boring operations. Provision is made for mounting milling cutters on the horizontal spindle, which is also fitted for driving boring-bars. Power feeds for longitudinal and cross movements of the work table are provided, which are conveniently controlled by the workmen.

By referring to the illustrations, it will be seen that the work table or platen is mounted on a large base which is made in two sections that are joined by angular ways. Obviously, with this construction, any movement of the upper section will result in a vertical adjustment of the table. This movement is effected by an angular screw, the squared end of which is seen projecting from the front. When the table is positioned vertically in this manner, the two members of its supporting base are rigidly locked by six bolts which



Combined Boring and Facing Mill, built by the Burke Machinery Co.

machine has a capacity for driving inserted-tooth milling cutters with a diameter of at least 14 inches.

The principal dimensions of the machine are as follows: Minimum distance from center of spindle to table, 7 inches; maximum distance from center of spindle to table, 11 inches; working surface of table, 18 by 54 inches; range of power feed for longitudinal and cross movements, 24 inches; ratio of gearing 12 to 1; width of driving belt, 3 inches; minimum and maximum diameters of steps on cone, 8 and 13 inches, respectively; taper in spindle, B. & S. No. 12; size of front spindle bearing, 4 1/2 by 7 3/4 inches; size of rear bearing, 3 1/2 by 5 5/8 inches; over-all height, 4 feet 6 inches; weight 4500 pounds; and floor space, 2 feet 6 inches by 6 feet 8 inches.

## AMERICAN HIGH-DUTY LATHES

The American Tool Works Co., Cincinnati, Ohio, is now building the design of high-duty lathe shown herewith. This new design is constructed to withstand severe duty, and its power, range, durability, rigidity, and convenience of operation, show clearly that careful attention has been given to every important detail in the construction. This design is built in 36- and 42-inch sizes, and it can be furnished with a

illustration shows, all levers and handwheels for the control are conveniently placed.

## The Geared Head

The geared head is arranged to give sixteen spindle speeds, all of which are obtained through slip gears and positive clutches. The clutches are of the selective type and easily engaged, and the teeth of the gears are machine-rounded so that they slide easily into mesh. All gears are mounted on

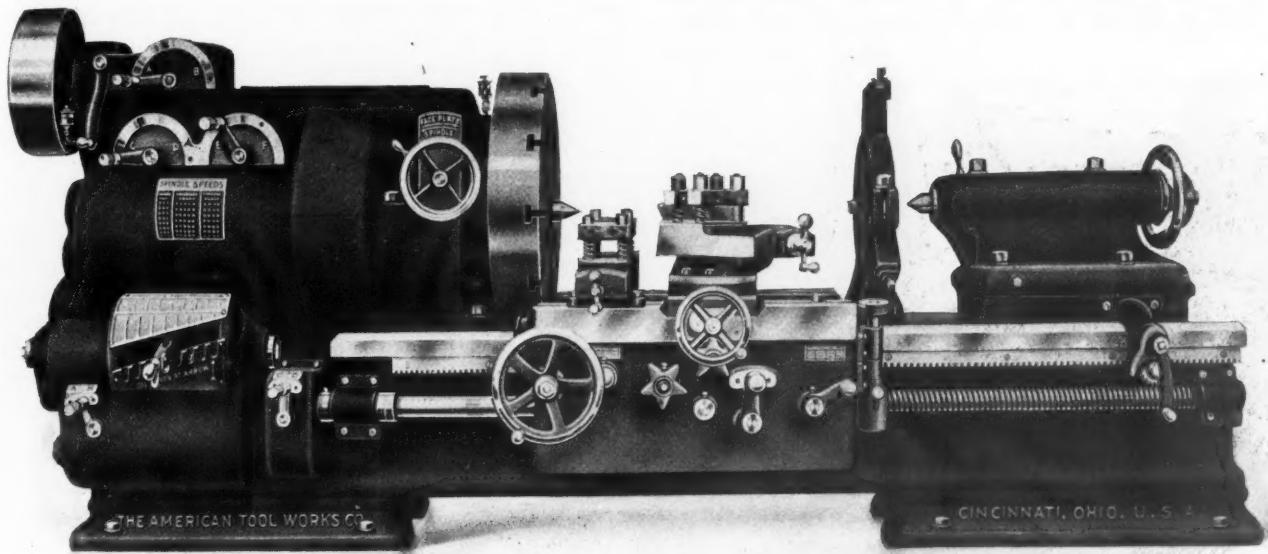


Fig. 1. High-duty Lathe, built by the American Tool Works Co.

single-pulley belt drive and geared head, as shown in Fig. 1, with a motor drive as in Fig. 2, or with a cone-pulley head as indicated in Fig. 3. The makers recommend a motor drive, as a lathe of this size requires easy access to crane service, and is frequently operated overtime. As sixteen spindle speeds are regularly provided, a constant-speed motor may be ad-

the long bronze sleeves which are oiled from the outside of the head by means of sight-feed oilers. Of the sixteen speeds available, eight are obtained directly through the spindle gear, and the remaining eight through the faceplate drive. By having a large range of speeds through the faceplate drive, the latter can be used for a great deal of heavy turning on work

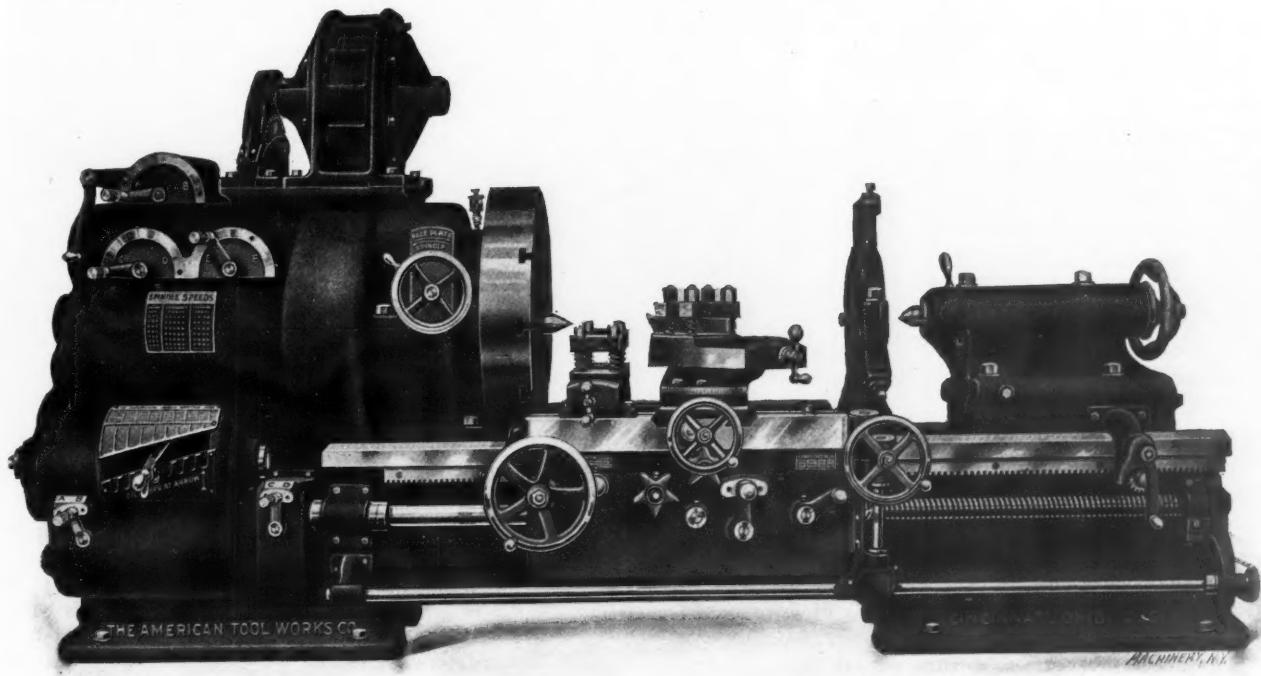


Fig. 2. American High-duty Lathe with Motor Drive

vantageously used. If, however, a variable-speed motor is preferred, a speed variation of only 35 per cent will be required.

In the design of the geared head, the number of running parts has been reduced to a minimum, to overcome any unnecessary waste of power, and the drive for both the spindle and feed mechanism is as direct as possible. The matter of lubrication has also received careful attention; thus insuring the delivery of a high percentage of power to the tools. As the

of large diameter, thus relieving the spindle of excessive strains. The head is so constructed that the power is transmitted either by short shafts or sleeves, there being no long shafts in torsion at any time. All gears in the driving mechanism are of coarse pitch and wide face, and the pinions are of steel cut from the bar. Another important point in the construction of the head is the elimination of all loose gears from the spindle. The only gear on the spindle is the

driving gear, which is set close against the front bearing so that the spindle is never under a severe torsional strain. The spindle is made in the taper form, which construction is common to heavy wheel lathes. The bearings throughout the head are all bored from the solid and are lined with phosphor-bronze bushings, and the bearings throughout the machine are also of phosphor-bronze. All speed changes can be made without stopping the initial drive, as the lathe may be started, stopped, or the speed reduced by means of a friction clutch which engages or disengages the driving pulley or motor gear. This clutch is operated by the lever seen to the right of the

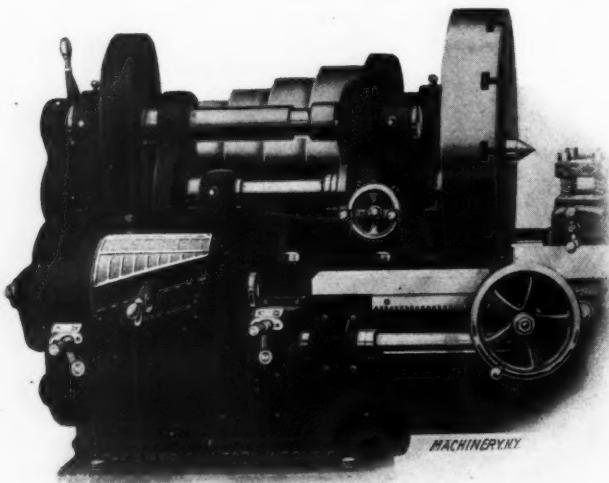


Fig. 3. Detail View of American Lathe with Cone-pulley Drive

driving pulley in Fig. 1. The various speed changes are made by operating the three handles or levers shown on the upper part of the headstock, in conjunction with the handwheel located just back of the faceplate, which controls the triple gear pinion. The positions of the levers for different spindle speeds are shown on an index plate, located just beneath the handles. This plate, a reproduction of which is shown in Fig. 4, is

THE AMERICAN TOOL WORKS CO., CINCINNATI, U.S.A.		
HANDLES ON	SPINDLE R.P.M.	FACEPLATE R.P.M.
ADE	250	19
BDE	180	14
ACE	130	10
BCE	95	7
ADF	70	5½
BDF	50	4
ACF	36	2½
BCF	26	2

Fig. 4. Index Plate showing the Position of Control Levers and Spindle Speeds. Fig. 5. Index Plate for the Feed-change Mechanism

simply arranged, and gives the revolutions per minute for the spindle and faceplate drives for different positions of the controlling levers.

#### Rapid Change-gear Mechanism

The rapid change-gear mechanism is embodied in a self-contained unit mounted on the front of the bed. This mechanism provides 32 fundamental changes for threading, ranging from 1 to 14 per inch. In addition to this, a compound quadrant gear located on the end of the bed, furnishes 16 additional changes, thus giving 48 threading and feed changes ranging from  $\frac{1}{2}$  to 28 threads (including  $1\frac{1}{2}$  pipe thread) and from 4 to 244 cuts per inch. The 32 changes in the box are all obtained through the medium of a cone and tumbler gear and two sliding clutches of the selective type. Any one of these changes may be instantly made while the machine is running. The quadrant gear previously referred to, supplements the regular feed mechanism and provides means for cutting threads of odd fractional or metric pitches or gives odd feeds

which may from time to time be desired. As the cone gears are all of the Brown & Sharpe 20-degree, involute, pointed type, the teeth are strong and the gears easily engaged while in motion. An important feature of this mechanism is that coarse threads and feeds are all obtained through the cone, and no member of the feed-box runs faster at any time than the initial driving gear. The different threads and feeds for different positions of the controlling levers, are plainly indicated on an index plate which is reproduced in Fig. 5.

#### Motor Drive—Single-pulley Belt Drive—Cone-pulley Drive

When a motor drive is employed, a motor of the constant-speed type for either direct or alternating current, is located on the geared head as shown in Fig. 2, and connection is made with the main driving shaft through spur gearing. The motor is constantly under the control of the operator, the controlling handle being conveniently located on the right end of the carriage, as shown.

The single-pulley type of drive is provided when a powerful belt drive is desired, and high efficiency is obtained by running the belt at the fastest speed consistent with good practice. The headstock is of the triple-gear type and is the same in construction as the one used with a motor drive. The pulley is bronze bushed and runs on a steel sleeve of large diameter, thus relieving the driving shaft from all belt pull. The pulley is self-oiling, the hub forming a retainer for the oil which is fed to the shaft through felt wipers. A single-pulley belt-driven machine can be easily changed for a motor drive, at any time after installation, by simply removing the pulley and placing a motor on the headstock and connecting it to the driving shaft of the head through spur gearing.

With the cone-pulley drive, the headstock is equipped with triple gears and has 12 spindle speeds. The detailed view, Fig. 3, shows the headstock end of a lathe arranged with this type of drive.

#### The Bed and Tailstock

The bed is of deep section, exceptionally heavy, and well braced by cross box-girths at short intervals throughout its length. It is the company's patented drop V-pattern which

THE AMERICAN TOOL WORKS CO., CINCINNATI, U.S.A.											
GEARS ON STUD BOX		THRD	FEEDS								
64	32	1	4	6½	7½	5	5½	3½	4	6	5½
32	16	1	8	1½	9	10	11	12	13	12	11
16	8	2	16	2½	18	20	21½	23	3	24	3½
8	4	3	32	4½	36	5	40	5½	44	5½	48
4	2	4	64	9	72	10	80	11	92	12	96
2	1	5	32	16	24	20	22	23	24	13	104
1	1	6	16	8	12	11	18	11½	22	14	112
32	16	7	32	16	24	20	22	23	24	13	104
16	8	8	64	9	72	10	80	11	92	12	96
8	4	9	32	16	24	20	22	23	24	13	104
4	2	10	64	9	72	10	80	11	92	12	96
2	1	11	32	16	24	20	22	23	24	13	104
1	1	12	16	8	12	11	18	11½	22	14	112
32	16	13	64	9	72	10	80	11	92	12	96
16	8	14	32	16	24	20	22	23	24	13	104
8	4	15	64	9	72	10	80	11	92	12	96
4	2	16	32	16	24	20	22	23	24	13	104
2	1	17	64	9	72	10	80	11	92	12	96
1	1	18	32	16	24	20	22	23	24	13	104
32	16	19	64	9	72	10	80	11	92	12	96
16	8	20	32	16	24	20	22	23	24	13	104
8	4	21	64	9	72	10	80	11	92	12	96
4	2	22	32	16	24	20	22	23	24	13	104
2	1	23	64	9	72	10	80	11	92	12	96
1	1	24	32	16	24	20	22	23	24	13	104
32	16	25	64	9	72	10	80	11	92	12	96
16	8	26	32	16	24	20	22	23	24	13	104
8	4	27	64	9	72	10	80	11	92	12	96
4	2	28	32	16	24	20	22	23	24	13	104
2	1	29	64	9	72	10	80	11	92	12	96
1	1	30	32	16	24	20	22	23	24	13	104
32	16	31	64	9	72	10	80	11	92	12	96
16	8	32	32	16	24	20	22	23	24	13	104
8	4	33	64	9	72	10	80	11	92	12	96
4	2	34	32	16	24	20	22	23	24	13	104
2	1	35	64	9	72	10	80	11	92	12	96
1	1	36	32	16	24	20	22	23	24	13	104
32	16	37	64	9	72	10	80	11	92	12	96
16	8	38	32	16	24	20	22	23	24	13	104
8	4	39	64	9	72	10	80	11	92	12	96
4	2	40	32	16	24	20	22	23	24	13	104
2	1	41	64	9	72	10	80	11	92	12	96
1	1	42	32	16	24	20	22	23	24	13	104
32	16	43	64	9	72	10	80	11	92	12	96
16	8	44	32	16	24	20	22	23	24	13	104
8	4	45	64	9	72	10	80	11	92	12	96
4	2	46	32	16	24	20	22	23	24	13	104
2	1	47	64	9	72	10	80	11	92	12	96
1	1	48	32	16	24	20	22	23	24	13	104
32	16	49	64	9	72	10	80	11	92	12	96
16	8	50	32	16	24	20	22	23	24	13	104
8	4	51	64	9	72	10	80	11	92	12	96
4	2	52	32	16	24	20	22	23	24	13	104
2	1	53	64	9	72	10	80	11	92	12	96
1	1	54	32	16	24	20	22	23	24	13	104
32	16	55	64	9	72	10	80	11	92	12	96
16	8	56	32	16	24	20	22	23	24	13	104
8	4	57	64	9	72	10	80	11	92	12	96
4	2	58	32	16	24	20	22	23	24	13	104
2	1	59	64	9	72	10	80	11	92	12	96
1	1	60	32	16	24	20	22	23	24	13	104
32	16	61	64	9	72	10	80	11	92	12	96
16	8	62	32	16	24	20	22	23	24	13	104
8	4	63	64	9	72	10	80	11	92	12	96
4	2	64	32	16	24	20	22	23	24	13	104
2	1	65	64	9	72	10	80	11	92	12	96
1	1	66	32	16	24	20	22	23	24	13	104
32	16	67	64	9	72	10	80	11	92	12	96
16	8	68	32	16	24	20	22	23	24	13	104
8	4	69	64	9	72	10	80	11	92	12	96
4	2	70	32	16	24	20	22	23	24	13	104
2	1	71	64	9	72	10	80	11	92	12	96
1	1	72	32	16	24	20	22	23	24	13	104
32	16	73	64	9	72	10	80	11	92	12	96
16	8	74	32	16	24	20	22	23	24	13	104
8	4	75	64	9	72	10	80	11	92	12	96
4	2	76	32	16	24	20	22	23	24	13	104
2	1	77	64	9	72	10	80	11	92	12	96
1	1	78	32	16	24	20	22	23	24	13	104
32	16	79	64	9	72	10	80	11	92	12	96
16	8	80	32	16	24	20	22	23	24	13	104
8	4	81	64	9	72	10	80	11	92		

ing of  $50\frac{1}{2}$  inches on the V's and an additional bearing on the top and inner surfaces of the front tailstock V, which resists the forward thrust of the tool and gives a bearing directly beneath it. The carriage is gibbed its full length at the back, and a clamp is provided at each end in front, the one to the right being for binding to the bed.

The apron is tongued, grooved and securely bolted to the carriage. It has the double-wall construction, thus giving all shafts a double bearing. Both longitudinal and cross feeds are reversed by a lever on the front of the apron. All the gears and pinions of the apron are of steel, cut from the solid with special cutters, and convenient means for thorough lubrication from the front are provided. The rack pinion can be withdrawn from the feed-rack when the lathe is being used for screw cutting, and it is impossible to engage, simultaneously, the screw-cutting and feeding mechanisms.

The top slide of the compound rest has a 14-inch power, angular feed, and a micrometer adjustment. It is equipped with a 4-stud tool-holder and two hardened steel clamps, the studs being so placed that the tool may be set outside of them

### BARDONS & OLIVER MOTOR-DRIVEN GEARED-HEAD TURRET LATHE

Bardons & Oliver, of Cleveland, Ohio, are now manufacturing the motor-driven geared-head turret lathe, shown in Figs. 1 and 2. This machine, as the illustrations indicate, is constructed throughout along modern lines. It is equipped with an automatic chuck, wire feed, power feed to the turret and cross slide, and an automatic throwout for the cross and longitudinal feeding movements. The convenience of control has received special attention, and all revolving parts are carefully guarded.

A motor with a speed variation of three to one is used, this range covering the intermediate steps between the two mechanically-obtained spindle speeds. The ratio of these two mechanically-obtained speeds is about three and a half to one, which the builders have found to be what is generally required for the quick or instantaneous changes on these machines. This gives a total speed range of about ten to one. The reverse or backward speed is also obtained mechanically.

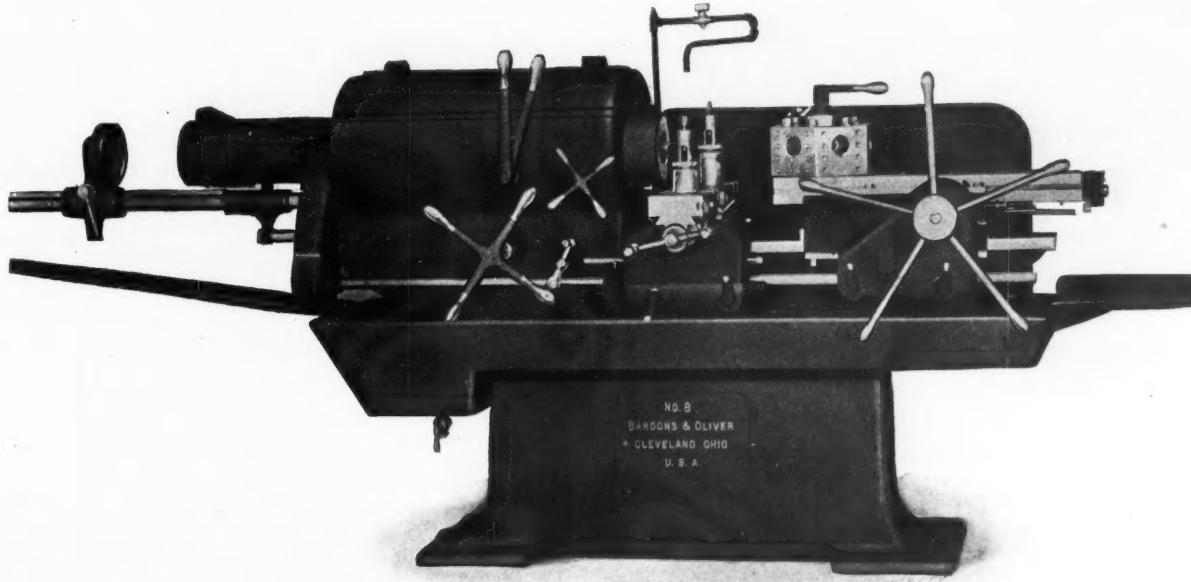


Fig. 1. Bardons & Oliver No. 8 Motor-driven Geared-head Lathe

in either a crosswise or lengthwise position. The swivel is graduated up to 90 degrees on each side of the zero mark.

#### Miscellaneous Features

The spindle of these lathes is made of high-carbon hammered steel and it runs in bearings of the best quality phosphor-bronze, that are equipped with sight-feed oilers. The lathe screw is exceptionally large in diameter, and it has one thread per inch, which permits the half nuts to be engaged at any point, when threading, without the use of the thread dial, except when cutting fractional threads. This screw is made from high-carbon round stock, and it is chased from a Brown & Sharpe master-screw and carefully tested by a special apparatus. The triple gears of the head are of the slip-gear type. The internal gear is planed integral with the faceplate, and the pinion is also integral with the steel shaft.

The principal dimensions of the 36- and 42-inch sizes are as follows: Standard length of bed, 12 feet; actual swing over the bed,  $37\frac{1}{4}$  inches and 44 inches; swing over the carriage,  $23\frac{3}{8}$  inches and  $30\frac{1}{8}$  inches; maximum distance between the centers with the tailstock flush, 4 feet for geared-head construction, and 5 feet with cone-pulley head; diameter of the hole through spindle,  $2\frac{5}{8}$  inches; taper of centers, Morse No. 6; size of tool ordinarily used, 1 inch by 2 inches. The beds can be furnished in any length from 12 feet up, advancing by 1-foot lengths. The regular equipment includes compound-, steady- and full-swing rests, countershaft for belt drive, and the necessary wrenches. An improved taper attachment, or a turret on either the carriage or shear, can be supplied extra, if desired.

by means of friction clutches on the spindle. A detailed view of the geared head with the hinged cover thrown back is shown in Fig. 3. The mechanical changes are obtained by operating the vertical levers shown, which are conveniently located for the operator.

On the machine illustrated, a Reliance, adjustable-speed motor is used, and the small turnstile to the right of the vertical levers, controls the speed changes of the motor. This machine is built in all sizes common to the belt-driven type made by this company, with the exception of two small sizes, designated as Nos. 0 and 1. In the No. 8 size, illustrated herewith, the spindle speeds may be varied from about 30 to 300 revolutions per minute. The motor, which is a 4 horsepower variable-speed type on the No. 8 size, is mounted on an extension of the column and does not require a separate foundation. The machine is furnished complete with all electrical equipment, and the motor is wound to suit the customer's voltage. If desired, however, the motor can be furnished by the customer, but in this event it must be shipped to the company in order that the machine may be tested complete.

A noteworthy feature in the design of the geared head of this machine, is the method of reversing the spindle. The reverse gear, which is engaged by a friction clutch operated by one of the vertical levers shown, is mounted on the spindle. With this construction, the spindle, which is the slowest running member in the driving train, is the only part reversed, all the other parts continuing to run in the same direction for forward or reverse movements of the spindle. The advantage of this feature, particularly for high-speed work, is obvious.

The oil pump used for supplying the lubricant to the cutting

edge of the tools, is of the rotary type. It is located in the head and is driven direct from one of the shafts. The system of lubrication for the headstock gears and clutches is illustrated in Fig. 4, which shows a sectional view of the main pinion shaft. This shaft, and also the second shaft, is drilled longitudinally and radially for oil channels, as shown, and the lubricant is supplied through oil cups located in the bearings, as shown to the left at *F*. Felt wicks are provided to retain the oil and feed it to the bearings. These wicks are located at *A*, *B*, *C*, *D* and *E*, and the radial oil holes leading to them are clearly indicated.

As before stated, all gears and moving parts are carefully guarded. The guard for the rear end of the spindle is provided with a hinged cap which can be lifted for adjusting the chuck.

The automatic chuck on this machine has a maximum capacity for 2½-inch round, 1½-inch square, and 2-inch hexagonal

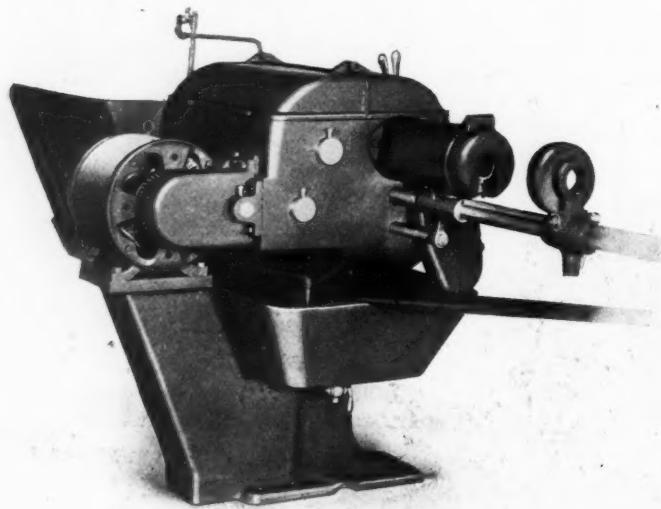


Fig. 2. Rear View of Bardons & Oliver Machine, showing Motor Drive

stock. The hole through the spindle is 2¾ inches in diameter, and the hole in the chuck plunger is 2½ inches in diameter. A maximum length of 11 inches can be turned, and the greatest distance from the end of the spindle to the face of the turret is 23½ inches, the saddle being even with the end of the bed. The swing over the bed is 19½ inches, and over the cut-off slide, 8½ inches. The hexagon turret measures 10½ inches across the flats, and it has an independent stop for each of the six positions. Each face is provided with a hole 2

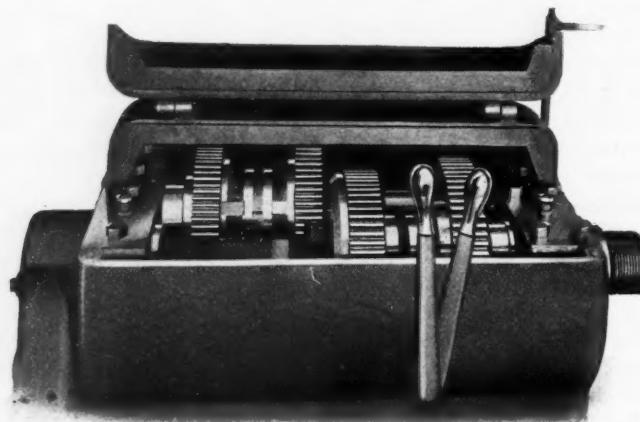


Fig. 3. Geared Head with Hinged Cover Thrown Back

inches in diameter, and, in addition, there are eight ½-inch tapped holes for bolting tools to the turret faces.

The machine illustrated is equipped with a No. 8 standard master collet and false jaws for one size of round stock. Extra false jaws for rounds, squares, and hexagons can also be supplied. Other extra equipment that can be furnished is as follows: A hollow turret stud which allows stock to pass through the turret; extra capacity automatic chuck; and a

standard set of tools for general work. This standard tool equipment contains one plain stop gage; one chamfering tool; one single cutter box-tool with roller back-rests; one multiple cutter box-tool with two adjustable tool-holders; two roller back-rests; two sockets for taper shank drills; one plain

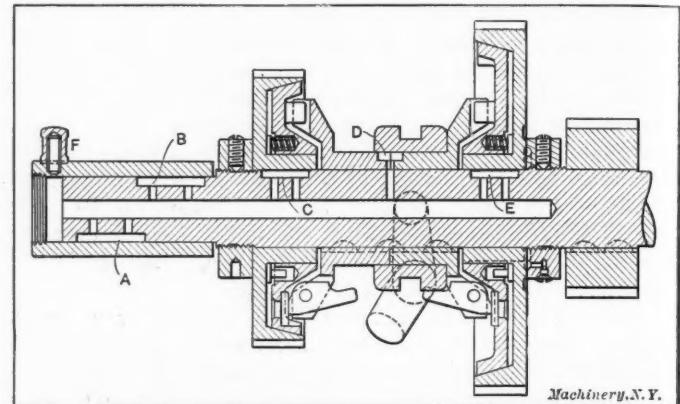
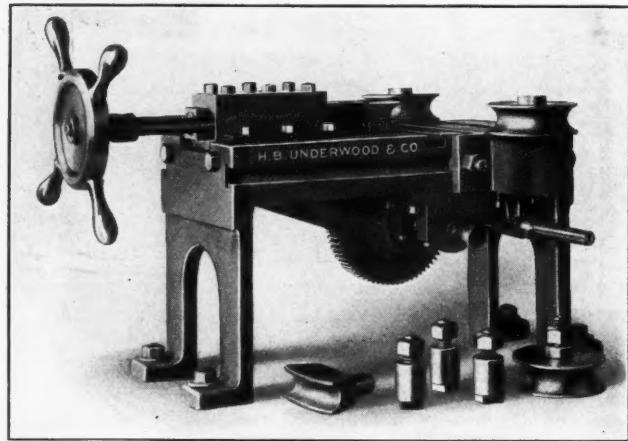


Fig. 4. Sectional View of Shaft in Geared Head, showing Lubricating System

drill-holder with collet; one cutting-off tool-holder and blade; and one 1½-inch self-opening die-head with six sets of chasers for threads ranging from 5/8 inch to 1½ inch in diameter.

#### UNDERWOOD POWER BENDER AND STRAIGHTENER

A machine of new design for bending pipe, structural iron, round or flat bars of various kinds and sizes, has been developed by H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa. This machine is also capable of straightening material in a quick and efficient manner. In its operation,



Underwood Belt-driven Bending and Straightening Machine

a multiplicity of dies or formers is not required, it being necessary to have only a set for the different diameters. These formers may be placed in different locations to permit bending a large variety of shapes and to different radii.

A belt drive is employed, and the ram is actuated by an eccentric shaft of small throw, which moves with a fixed stroke. The shaft is powerfully back-gearred, thus giving the ram tremendous power. Sliding in this reciprocating ram is another which carries the former to be used and this is moved in or out by operating the handwheel shown. In this way, a very delicate adjustment is obtained which enables the work to be formed with considerable accuracy. Any number of pieces can be bent to practically the same shape, by noting the last position of the handwheel. The effect of bending in this manner, that is, by having the former follow up the work and exert a comparatively slight pressure at each stroke, is much better for the material than a sudden bend or shaping of the piece in one movement.

The formers or resistance studs on each side of the bed, slide in a T-slot as shown, and there are also transverse T-slots for formers, which make possible many different arrange-

March, 1911

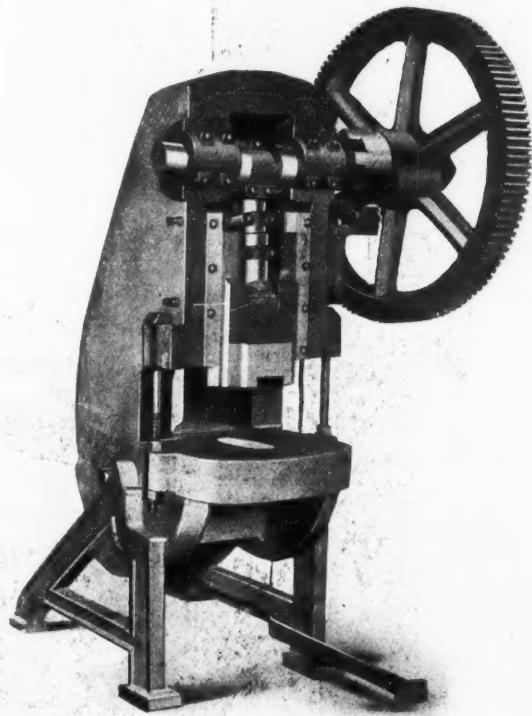
## MACHINERY

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ments. With this machine pieces of pipe, bars, etc., that have been bent into various shapes, can be quickly and easily straightened. Little skill is required in the operation of this tool, as the workman simply moves the pipe along and turns the handwheel to suit requirements.

### DANVILLE COMBINED PRESS, SHEAR AND PUNCH

The Danville Foundry & Machine Co., Danville, Pa., is now manufacturing the combination trimming press, slitting shear, and punch, a front view of which is shown herewith. This press can be furnished for either a belt or motor-drive. The particular machine illustrated is motor-driven, the motor being mounted on a bracket attached to the rear of the frame. The stroke of the press is  $3\frac{1}{4}$  inches, and the knives, which have four cutting edges, are 10 inches long. The main housing is open in the back so that long narrow bars can be sheared. The opening between the housings is 12 inches, and the depth of the throat is 8 inches from the shear cutting edge. The driving gears are all cut to insure quiet operation. The



Combination Trimming Press, Shear and Punch

main crosshead is adjusted to suit different classes of work by means of a right- and left-hand screw. There is also provision made for taking up wear on the crosshead by means of adjustable V-shaped guides. When the knife-holders are removed, a punch-holder can be inserted for punching operations.

This press requires a floor space of 4 feet by 3 feet 6 inches. It has been designed especially for drop-forging works, or other metal-working establishments requiring shearing, punching, or pressing machinery.

### GORTON SPECIAL ENGRAVING MACHINE

The engraving machine shown in Fig. 2 is a special design built by the Geo. Gorton Machine Co., Racine, Wis., for engraving names in automobile tire molds. The head of this machine is similar to the type used on the regular line of engraving machines manufactured by this company, but the frame and work table are of special construction. The mold-ring in which the firm name, trade name, and size of tire is engraved is shown in Fig. 1. This ring, which is of cast iron, is mounted on the large circular work-table, and the revolving graver or cutting tool, guided by a copy or master-pattern, cuts out the letters as shown on the finished ring illustrated. The copy is clamped in a holder at the rear of the head and

the outline of its enlarged letters is followed by a small pin in the arm of the pantograph reproducing mechanism, which is worked by the hand of the operator. As the letters of the copy are traced in this manner, they are reproduced in the work on a smaller scale by the graver, the ratio of the reproduction being controlled by the setting of the pantograph arms. As the engraved surface of the mold ring is concave to conform to the shape of the tire, it is necessary to give the

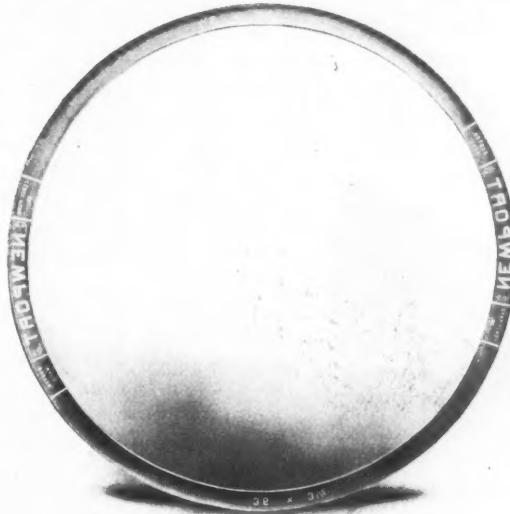


Fig. 1. Tire-mold engraved on Machine illustrated in Fig. 2

cutter a vertical movement in addition to its regular movement, so that all parts of a letter will be cut to the same depth. To accomplish this, the spindle is held in contact (by a spring) with a small templet mounted above it, as shown in the illustration. This templet has the same radius as the curved part of the mold, and it guides the spindle up and down as the cutter is moved across the convex surface. The

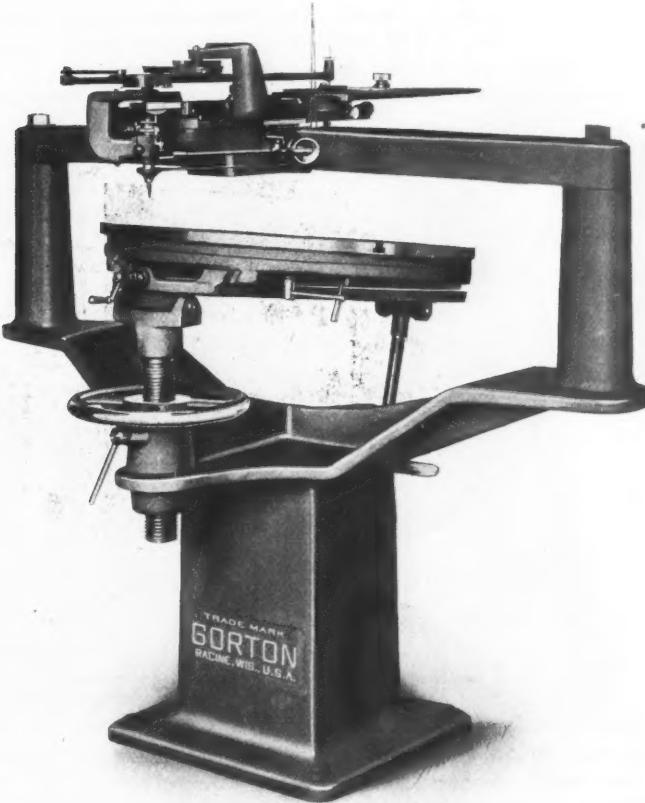


Fig. 2. Engraving Machine specially designed for Engraving Automobile Tire Mold Rings

work in this particular case is an example of intaglio or sunk engraving, the letters on the tire being, of course, raised. These machines are, however, adapted to engraving letters in relief if desired.

### LANDIS SOLID ADJUSTABLE DIE-HEAD

A solid adjustable die-head has been brought out by the Landis Machine Co., Waynesboro, Pa., that is designed to take the place of the solid dies now used on screw machines and other types of machines in which the work is backed out of the die after the thread is cut.

This die-head, the 1-inch standard size of which is illustrated herewith, has a capacity for threads varying from  $\frac{1}{4}$  inch to 1 inch in diameter, so that it is adapted to a wide range of work. The chasers are adjusted to and from the center on radial lines, for different sizes, and they are held rigidly in their seats. These chasers, one of which is illustrated in Fig. 1, can be ground to suit the material being operated upon. Any amount of rake can be given that is necessary, thereby insuring the best possible cutting conditions and securing ideal results.

The chasers are made from high-speed steel, and they can be ground and re-ground many times, thus giving a long life. Adjustments for wear are readily made, in addition to the adjustment for different diameters. If desired, the chasers can readily be set above or below their rated diameter; that is, any diameter within the range of the head can be cut with one set of chasers so long as the pitch is the same. For instance, the  $\frac{1}{2}$ -inch chasers (having 13 threads per inch) can be set to cut 1 inch in diameter, and they can also be set for a  $\frac{1}{4}$ -inch thread. The angle of the thread, however, while not ideal, will be all that is required on ordinary screw machine work. In special cases where great accuracy is required, it would be advisable to use special holders.

These heads can be supplied in standard sizes with shanks suitable for holders in ordinary screw machines. The  $\frac{1}{2}$ -inch head is  $2\frac{1}{4}$  inches in diameter, and is capable of cutting a thread  $1\frac{1}{2}$  inch in length. The 1-inch head is  $4\frac{1}{8}$  inches in diameter, and it will cut threads  $2\frac{1}{2}$  inches long. Other sizes with special shanks can be made to order.

The special advantages claimed for this type of head are

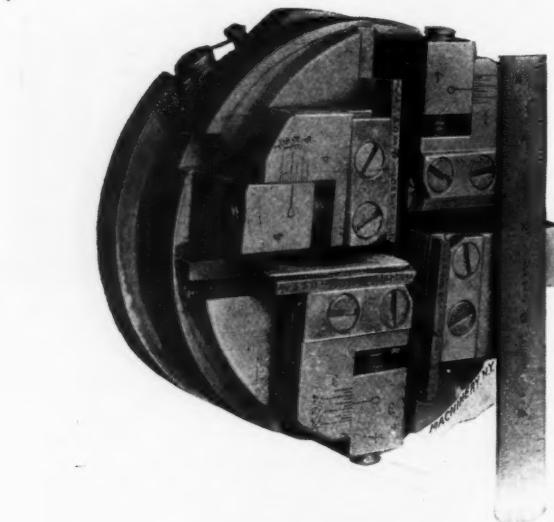


Fig. 2. Landis Solid Adjustable Die-head for Automatic Screw Machines, etc.

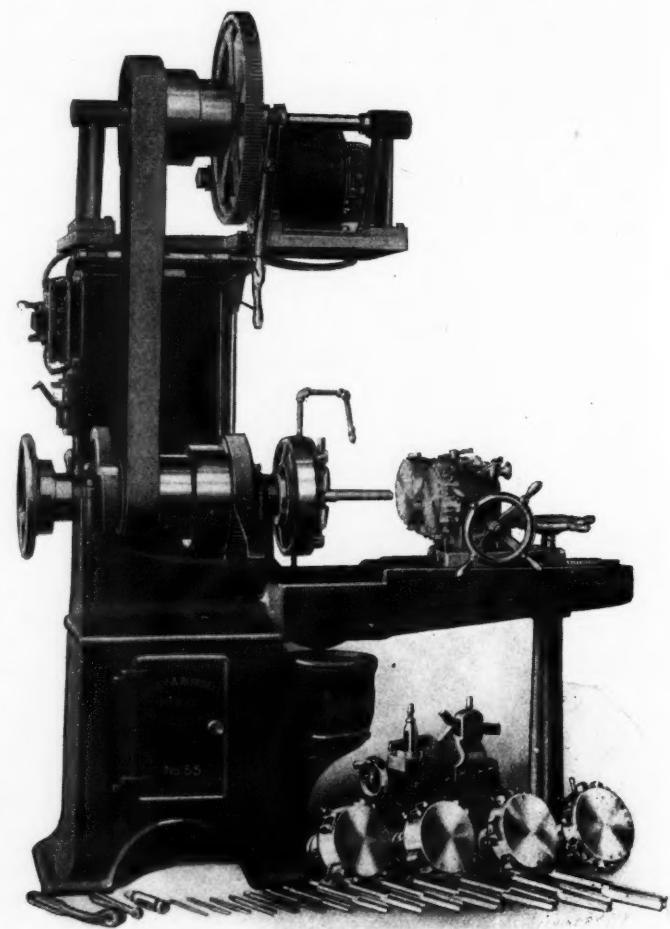
that it will permit comparatively high cutting speeds; it has a long life; a wide range; independent adjustment for any one chaser of a set; and when the chasers are ground, the die is as good as new. Any chaser of a set can be replaced without replacing the complete set.

### WILEY & RUSSELL THREADING, TAPPING AND CUTTING-OFF MACHINE

In the department of New Machinery and Tools for June, 1910, we illustrated and described a combined bolt-cutter, nut-tapper, pipe-threader and cutting-off machine built by the

Wiley & Russell Mfg. Co., Greenfield, Mass. This type of machine has recently been equipped with a self-contained motor drive, as shown in the accompanying halftone.

The shelf for the motor is attached to a bracket that is fitted and bolted to the bed. This shelf is hinged at the back and it has finished projecting lugs which rest on a cam-shaft operated by lever A. By this means, sufficient tension can be kept on the belt at all times, and the belt can also be quickly slackened when it is desired to shift it from one step to another on the cone pulley. After the belt is tightened, the cam-shaft is locked with a binder. The lever B controls a clutch engaging the large spur gear shown, so that the bolt-cutter can be stopped independently of the motor. The motor is of constant-speed type and it is fitted with a rawhide driving pinion. A motor of two-horsepower capacity is required. It



Wiley and Russell Combined Bolt-cutter, Nut-tapper, Pipe-threader and Cutting-off Machine with Motor Drive

can be furnished for direct or alternating current, and it may be reversing or non-reversing as desired. The starting rheostat is mounted in a convenient location on the side of the motor-supporting bracket, as shown.

The dies used on this machine are the company's standard quick-change opening dies. The dies proper are held in two die-heads, which are revolved to bring any size die within their capacity in the working position.

This machine is strongly constructed throughout, and it is guaranteed to cut bolts and pipes up to 2 inches in diameter. Its weight, complete with the motor drive, is 2300 pounds.

### BAIRD DOUBLE HORIZONTAL TILTING TUMBLER

In the department of New Machinery and Tools for July, 1909, we illustrated a double horizontal tilting tumbler, built by the Baird Machine Co., Oakville, Conn. This machine has been redesigned, as shown in the accompanying view. The barrels are driven by friction clutches, which allows them to be started easily and without shock when heavily loaded. The wood-lined cast-iron covers formerly used, have been

replaced with brass covers, as the former became leaky if not properly cared for, allowing the water and small burnishing balls to trickle out. The brass cover requires no lining and remains tight, a rubber gasket being used, of course, around the joint. Cast brass is used for the covers, as German silver, brass and plated articles should not be rolled against an iron surface. When this type of tumbler is in operation, the barrels are in a horizontal position, but they may be easily tilted



Baird Steel Ball Burnishing and Buffing Barrel

for emptying or filling, as they are supported on trunnions mounted in heavy yokes that are attached to the driving shafts. The locking device which holds the barrels in a horizontal position, is simple and convenient to operate. Both barrels are driven through bevel gears and friction clutches. As either barrel may be operated independently, one can be at work while the other is being emptied or filled. All bearings are bronze-bushed, and the main shaft bearings are ring oiled. The barrels are polygonal in shape and are lined with maple. The length of each barrel is 24 inches and the inside diameter, 10½ inches. It has been the company's experience that a small diameter lessens the danger of bending, denting or otherwise injuring small or delicate parts, without retarding the speed or quality of finish.

#### STANDARD SPECIAL MULTIPLE PRESS

An interesting multiple press equipment has recently been brought out by the Standard Machinery Co., 7 Beverly St., Providence, R. I., which consists of three presses mounted on the same bed, as shown by the accompanying halftone. This machine is designed for piercing pieces of unusual length, that cannot be handled in a gang piercing press, there being one stationary and two movable presses for performing separate operations.

The three presses are of the open-side type, and the frames are a modification of those used on the maker's No. 7-S press. The center press is stationary, being rigidly attached to the center of the bed, and the two end presses are adjustable. The bases of the adjustable presses are fitted to dovetailed ways, as shown, and adjustments are effected by a square-threaded screw that extends through the center of the bed and is actuated by the crank seen to the left. This screw passes through bronze nuts that are attached to the bases of the movable presses.

The work for which the particular machine illustrated was

intended, required three different locations for each of the adjustable presses, the center-to-center distances between the central and outer presses varying from 22 to 43 inches. These locations are positively and accurately obtained by taper keys which fit corresponding keyways cut in the bed and base, as shown. These keys are fitted with set-screws in the outer ends, for drawing them when an adjustment is desired. In addition to the keys, the movable presses are also provided with powerful clamping screws at the back, so that they can be located in any desired position.

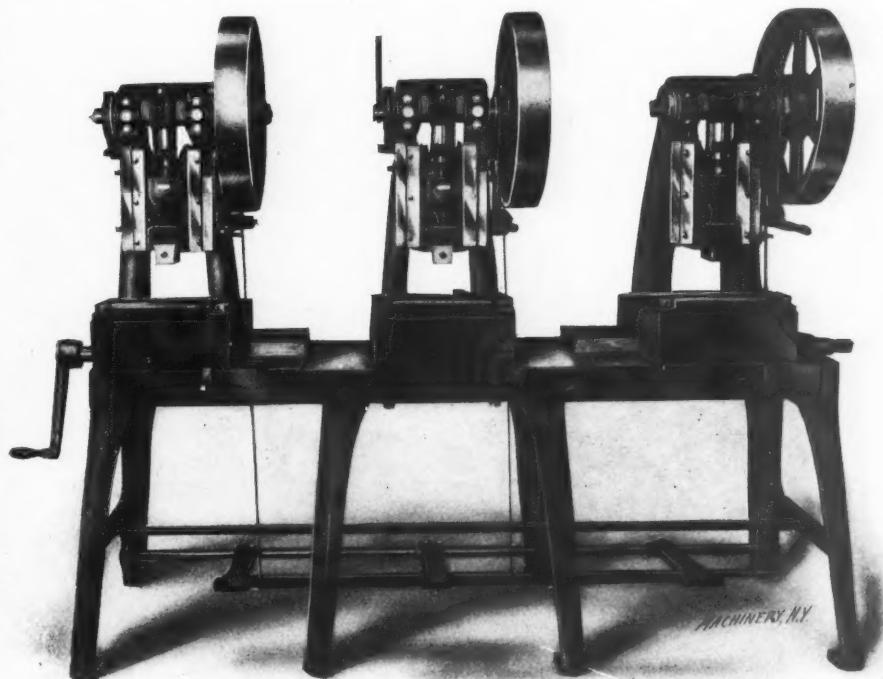
The presses can be run either singly or simultaneously. When they are all in operation at the same time, the clutch mechanism is controlled by a single treadle which connects the three individual treadles together. When each press is operated independently, the hand levers seen just beneath the flywheels are used for tripping the clutch.

The overall height of this machine is 6 feet 8 inches, and the overall length of the bed is 7 feet 6 inches. The bed is 6 inches thick, and it contains a slot beneath each press to allow pieces to drop through into boxes or carriers. The height of the table of each press from the floor is 40 inches. The flywheels have a diameter of 23 inches, a face width of 3½ inches, and the wheel rims weigh 200 pounds. The machine runs at a speed of 100 revolutions per minute. The stroke of each press is 1½ inch; width between the gibs, 4½ inches; width of opening in the back of the frame, 7 inches; and adjustment 1½ inch. The end machines can be adjusted while the balance wheels are running, there being a special countershaft which carries wide-faced driving pulleys for the end presses, to permit the necessary adjustment.

This equipment is particularly adapted for the piercing of angle-irons, long flat plates, and other work of a similar nature.

#### COMBINATION TOOL-ROOM GAS FURNACE

The Rockwell Furnace Co., 26 Cortlandt St., New York, has recently placed on the market a new combination tool-room furnace to use gas fuel only, which is illustrated herewith.



Special Press for Piercing Long Work

This furnace was designed for tool departments in which a variety of small tools made from both high-speed and carbon steels have to be heat treated and where accurate temperatures are required. It is claimed that a working temperature is possible within eight minutes of lighting the cold furnace. In size the furnace is very small, as shown by Figs. 1 and 2, the floor space occupied being only 16 inches square.

For end-heating carbon steel tools such as reamers, taps, and tools of this type under 1½ inch diameter, the furnace is

used as in Fig. 1, the work being introduced into the entrance *cc*, which is  $1\frac{1}{2}$  inch in diameter. Fig. 2 shows this furnace arranged as an oven furnace for heating carbon steel tools, such as dies, cutters, etc. The heating chamber *gg* is used, this chamber being 7 inches long, 4 inches wide by 3 inches high. When desired to use it as a muffle furnace, the bottom tile *H* shown in Fig. 1 on the ledge, may be removed and the muffle *J* shown on the ledge in Fig. 2 may be inserted. This has an inside height of  $2\frac{3}{4}$  inches.

As a cylindrical furnace for hardening high-speed steel tools, the muffle and bottom tiles are removed and tools up to 8 inches long by  $1\frac{1}{2}$  inch in diameter may be suspended in the heating chamber through the opening *ii*. By the removal of the annular tile surrounding this hole, tools up to 3 inches in diameter may be inserted.

For lead hardening, the iron pot *I* shown on the ledge in Figs. 1 and 2 is placed in the entrance *ii*. The heat is evenly distributed over the body of the pot, and the lead bath can be kept at the desired temperature for an indefinite period without danger of overheating. A similar method is followed for oil and sand tempering, these mediums being placed in the iron pot referred to.

The pipe arrangement for the gas fuel and air is shown to the rear, and the supply is controlled by two valves *A* and *B*.

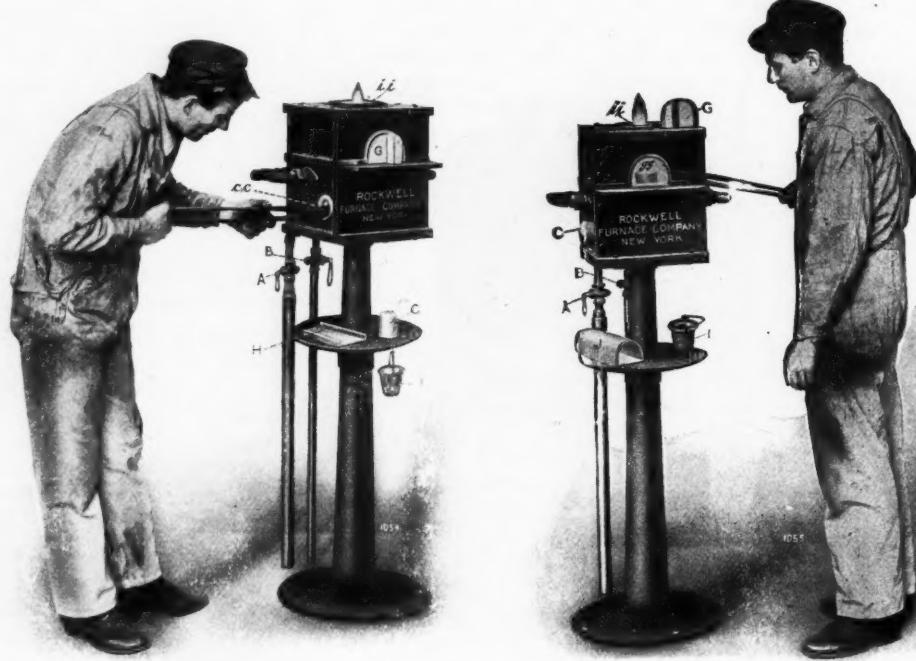
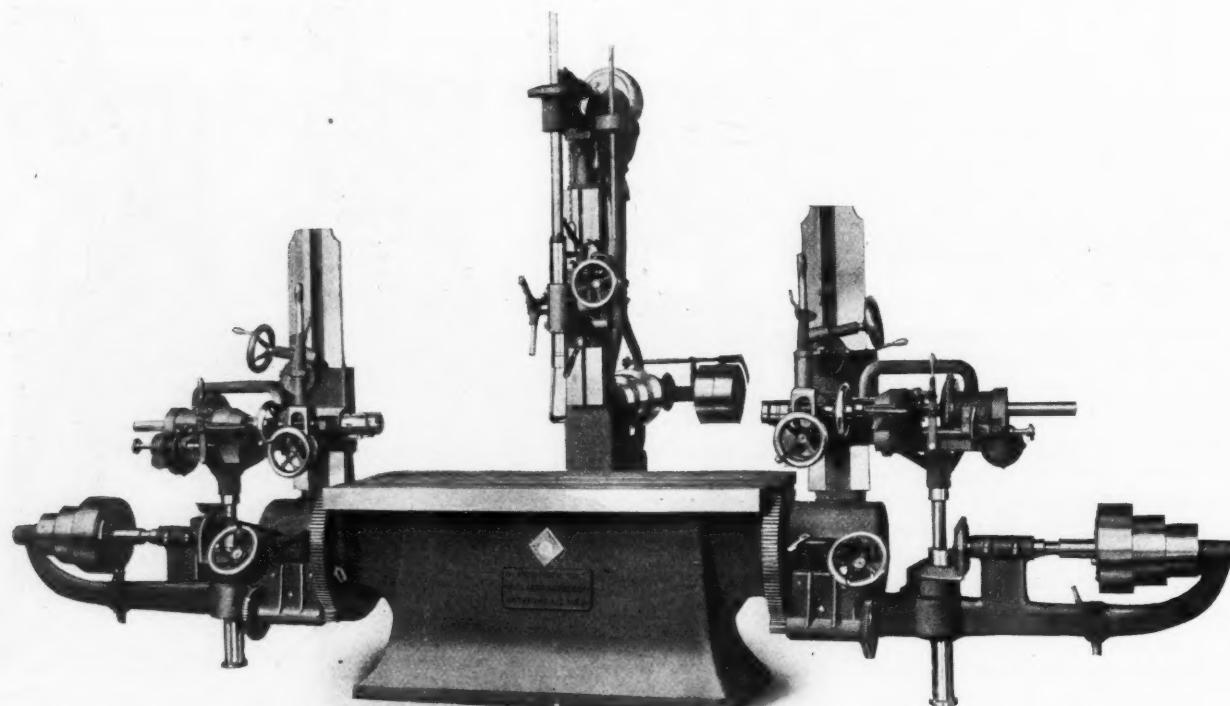


Fig. 1. Rockwell Tool-room Gas Furnace End-heating Carbon Steel Tools

Fig. 2. Rockwell Tool-room Gas Furnace as an Oven Furnace with Muffle Removed

machine, which is shown in the accompanying view, is composed of the main parts of the regular No. 3 horizontal radial drill, together with one of the company's sliding head gang drill heads. The machine was designed for a special job which consisted of a casting in which it was desired to bore one or more holes in each end, in addition to a hole on top. With



Horizontal and Vertical Drilling Machine built by W. F. & John Barnes Co.

The furnace is very substantially constructed, being made of cast iron throughout, and is lined with the best quality of fire brick. The gas consumption per hour varies from 80 to 130 cubic feet. As the makers emphasize, it is a very convenient furnace, combining all the features of eight complete furnaces in one.

this design, it is unnecessary to change the position of the work after it has once been set in order to drill any of the holes with the three drill heads, within the limit of the machine.

As just mentioned, the end heads are the same as those used on the No. 3 horizontal radial drill which was described

in detail in the December, 1908, issue of *MACHINERY*. As will be recalled from the previous description of the end head, the spindle is capable of all the movements and adjustments of a regular radial drill, only it is in a horizontal instead of a vertical position. The only adjustment which is not provided is that corresponding to the raising and lowering of the radial arm.

In the machine here illustrated, the spindle travel of the horizontal head is 18 inches, which is sufficient for the special parts to be drilled. A swing adjustment of the head is provided through the handwheel shown, which connects through a worm and worm-gear with a pinion meshing with a segment-gear attached to the frame. The spindles have No. 4 Morse taper holes and they are provided with positive geared feeds. The vertical head is the same as that used on the regular sliding head gang drills of the same size, and is attached to a sliding rail at the back of the machine, being therefore adjustable horizontally. The vertical head can thus be set at any position between the horizontal heads.

The platen of the machine is 24 inches wide by 65 inches long, corresponding to the previously mentioned No. 3 horizontal radial drill. All cone-pulleys on both the horizontal drill heads and the vertical drill head have three steps for a 4-inch wide belt, and all cones are back-gearied. The horizontal spindles, as well as the vertical spindles, are equipped with an automatic stop.

The machine weighs complete about 7000 pounds, and occupies a floor space about 16 feet long by 7 feet wide.

### MORSE NO. 2 UNIVERSAL GRINDING MACHINE

The Morse Twist Drill & Machine Co., New Bedford, Mass., in designing the universal grinder illustrated in Figs. 1 and 2, aimed to produce a machine that is durable, convenient to the operator, and capable of accurate results. The general construction is not radically different from other well-known makes, but a number of changes that have been found desirable are incorporated in the design.

The table has an automatic reciprocating movement, and the point of reversal is controlled by dogs in the usual manner. The table can be stopped at any point by a lever at the front of the machine, thus leaving it free to be traversed by a handwheel. The rate of the table traverse can be quickly changed, for roughing or finishing, by means of a feed-box

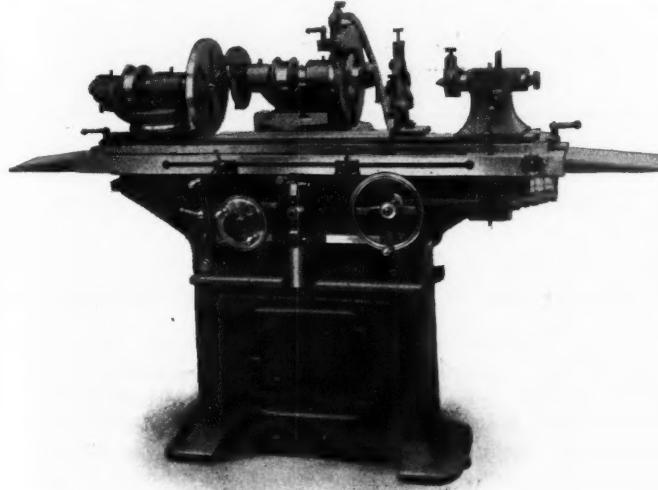


Fig. 1. Twelve- by Thirty-inch Universal Grinder built by the Morse Twist Drill & Machine Co.

attached to the rear, as shown in Fig. 2. These changes are effected by the operation of a lever. The table has a swiveling platen which turns on a hardened and ground central stud. This platen is clamped at both ends, and the swiveling movement permits the grinding of tapers as great as  $1\frac{3}{4}$  inch per foot. A scale indicates the taper, and the adjustment is made by a screw at one end.

The wheel-slide has a swiveling base graduated in degrees

and it is adjusted by a handwheel having a dial graduated to indicate thousandths of an inch on the diameter of the work. The automatic cross-feed will size work to within 0.00025 inch. The wheel and slide are held back by means of a weight which prevents any lost motion and insures an even and equal feeding movement. The way in which this weight is attached to the wheel-slide is indicated in the sectional view, Fig. 3. A bracket carrying a grooved roller is bolted

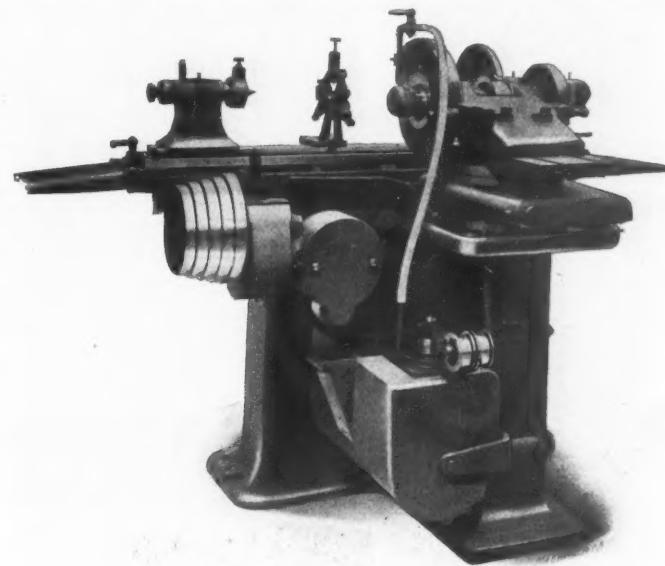


Fig. 2. Rear View of Morse Grinder

to the saddle, and passing over this roller is a cable W, one end of which is fastened to the wheel-slide while the other is attached to a weight. As the engraving shows, this cable passes through the center of the vertical feed-shaft, and does not interfere with the swiveling movement of the slide.

The wheel spindle is hardened, ground and lapped and runs in phosphor-bronze boxes which may be adjusted if necessary.

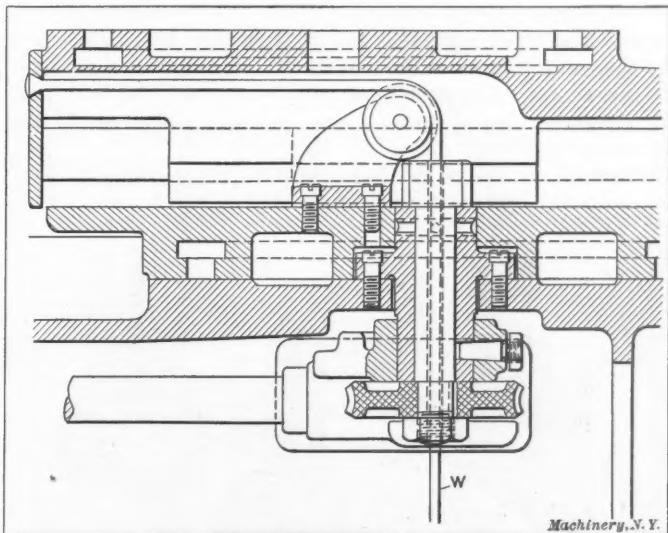


Fig. 3. Section of Wheel-slide

It will take wheels 12 inches in diameter and from  $\frac{3}{8}$  to  $\frac{3}{4}$  inch thick, and 7 inches in diameter with a thickness of  $\frac{3}{8}$  inch. The headstock and footstock are clamped to the table ways by levers, and the base of the former is graduated in degrees. The headstock spindle is threaded and it has a No. 3 Morse taper hole. Provision is made for locking the spindle when grinding on dead centers. Provision has been made for wet grinding, there being a pump of ample capacity and the necessary piping. The water tank is suspended on trunnions, as shown in Fig. 2, so that it may be easily cleaned. There are two shifter levers connecting with the overhead works, one of which controls the drive for the wheel and feed and the other the work and pump. The countershaft has 12-inch tight-and-loose pulleys for a 3-inch belt, and it should run at 300 revolutions per minute. The work speeds may be varied

from 50 to 480 inches, and the wheel speeds range from 1025 to 3333 revolutions per minute. Both the work speeds and wheel speeds have six changes, and there are ten changes to the traverse of the platen, varying from 12 to 100 inches per minute. The net weight of the machine is 3750 pounds.

The equipment includes a No. 4 internal grinding fixture; 8-inch four-jawed chuck; large faceplate; 2 universal backrests; center-rest; set of dogs; one emery wheel 12 inches in diameter,  $\frac{3}{8}$ -inch face; one emery wheel 7 inches in diameter,  $\frac{3}{8}$ -inch face; overhead works; wrenches, etc.

### ALMOND TOOL-HOLDER

The tool-holder shown in Fig. 1 is the product of the T. R. Almond Mfg. Co., Ashburnham, Mass. This holder is of a simple, practical design, and it is adapted to a wide range of work, as each of the various types of cutters which it holds can be placed in five different positions. The cutter is held by a bolt and clamp which have beveled or dovetailed gripping faces, so that when the bolt is tightened, the cutter

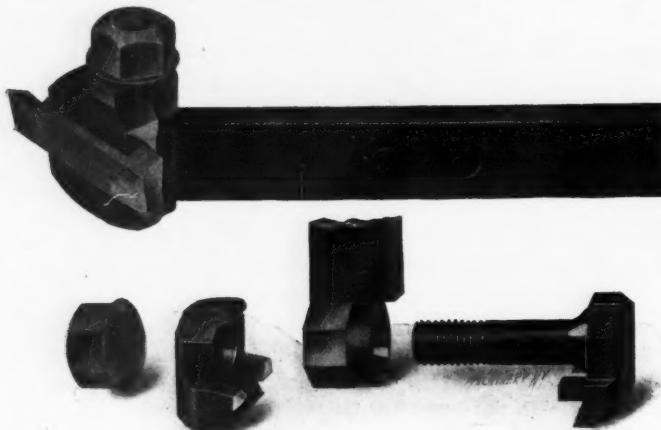


Fig. 1. Almond Tool-holder and Parts

(which is also beveled), is drawn against one of the five faces of the octagonal-ended shank. With this construction, the cutter is gripped positively and it is further held in position by the octagon faces of the bolt which come against a shoulder on the shank. Any style or shape of cutter may be held, and, if necessary, special cutters may be quickly filed to fit the clamping members.

Thirteen cutters of various kinds are furnished with each complete set. These include right- and left-hand and round-

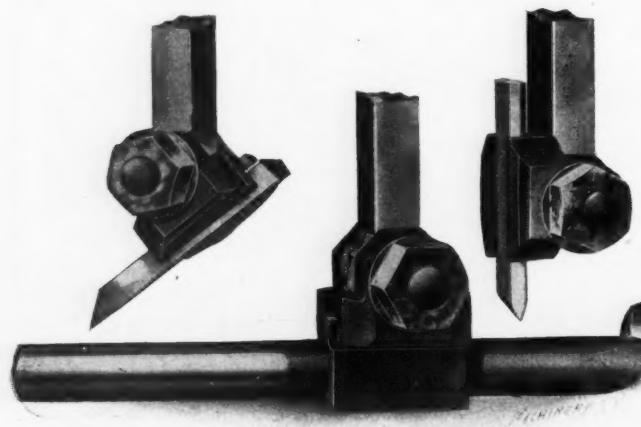


Fig. 2. Side-tool, Threading Tool, and Method of Holding Boring Tool

nose turning cutters; right- and left-hand side-tools; wide and narrow cutting-off tools; threading tools for roughing and finishing; a spotting or centering tool; heavy and light boring tools; and an inside threading tool. All of these tools are made from merchant bar stock. The square turning cutters are held in split bushings and are clamped their entire length on four sides, when in the working position. The tools for spotting, boring, and threading are held in split bushings and

they may be adjusted for length, as required. The holder with a boring tool in place, is shown in Fig. 2. The tool shank passes through a split bushing which is firmly gripped by the beveled faces of the bolt and clamp. This illustration also shows a side-tool in a right-hand offset position, and a threading tool in a left-hand side position.

For high-speed rough turning, the makers' recommend high-speed steel cutters made similar to the side tools, but having

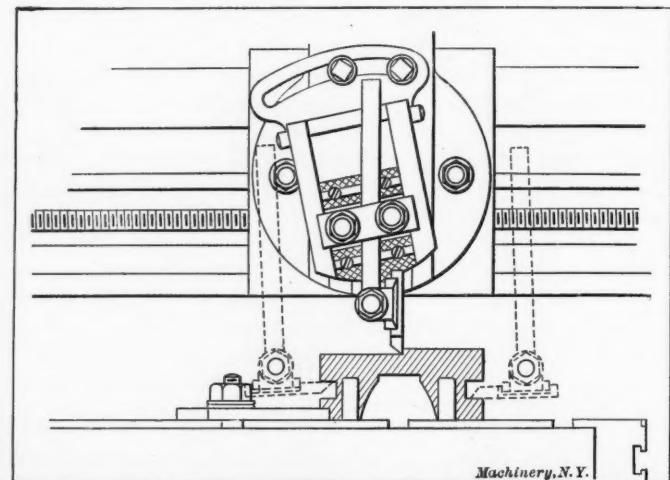


Fig. 3. Almond Tool-holder as applied to Planer Work

cutting points ground curved and with top rake. This design of cutter gives  $\frac{3}{4}$  inch of metal to back up the cutting point and take away excessive heat.

Figs. 3 and 4 show two of the many classes of work for which this holder is adapted. Fig. 3 is a planer job requiring a cut across the top and finished slots at the sides. The slots

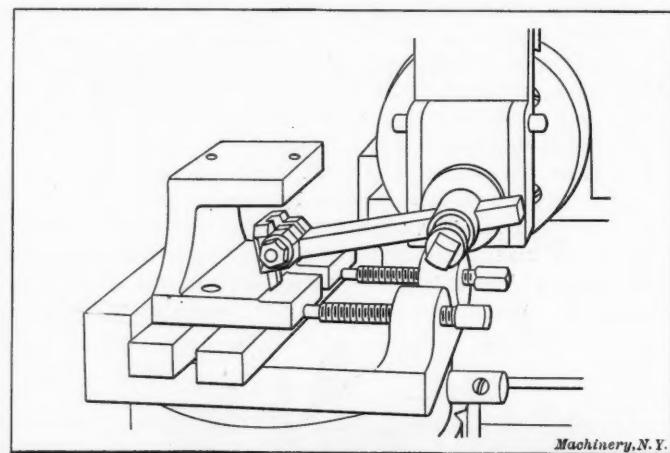


Fig. 4. Planing Operation in the Shaper

after being roughed out with a cutting-off tool, are finished by a side tool, as the dotted lines indicate. Fig. 4 is a shaper job, and the illustration is self-explanatory.

### GARVIN NO. 9 INDEX MILLING MACHINE

The Garvin Machine Co., Spring & Varick Sts., New York City, is putting on the market the index milling machine shown in Fig. 1. This machine is particularly adapted for cutting spur gears or sprockets, notching operations, grooving shafts, gashing bevel gears and pinions preparatory to planing, etc., and it will cut steel at the rate of 9 inches per minute with the cutter running at 100 revolutions per minute. The operation of the machine is completely automatic, and it is capable of multiple working, which, with the capacity and power available, insures efficient results.

The safety index device on the machine is a special feature which disengages the feed automatically, if the completion and locking of the indexing is prevented by accident. The indexing is positive, but there is the further assurance that if anything should happen, work cannot be spoiled. The return of the table and the indexing take place at a constant rate. The table is wide and it has integral with it a large

chip basin that gives ample room for large multiple centers. Different index centers and fixtures can be mounted interchangeably on the table, having from two to eight spindles, all of which index automatically and simultaneously. To compensate for variations in the diameters of gear-cutters and form cutters, multiple centers can be furnished with spindles having individual micrometer adjustments, thus enabling very accurate work to be done on multiple centers.

An example of one of these multiple centers is shown in Fig. 2. This is a three-spindle fixture, one spindle having a fixed center while the other two may be adjusted to compensate for variations in the size of cutters. This adjustment is made through a micrometer screw and wedge, and there is provision for locking the adjustable parts. Small bevel gears can be cut side by side, in similar centers of a tilting type, and large bevel gears can be cut tandem on a special fixture such as the one illustrated in Fig. 3. The bevel gears shown in this illustration are 11 inches in diameter; have a face width of  $1\frac{1}{2}$  inch; 43 teeth of four pitch; and are

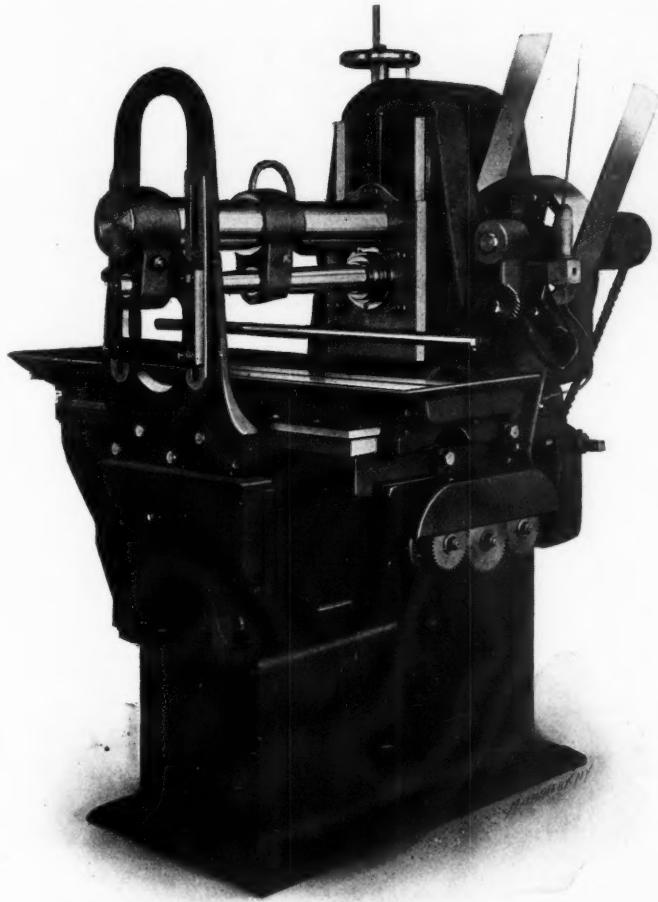


Fig. 1. No. 9 Automatic Index Milling Machine built by the Garvin Machine Co.

made of  $3\frac{1}{2}$  per cent nickel steel. Both of these gears can be cut in thirty minutes or at the rate of fifteen minutes each.

The table is fed by means of a large screw running in a trough of oil in which the nut also travels. The feeding and indexing mechanisms are combined in one large box located in front of the machine. The gears run in oil, and the box can be inspected by swinging down the front cover shown; by removing four bolts the box can be taken out. Changes for feed are made by change gears located inside the front cover, and the change gears for indexing are mounted on the right-hand side of the bed.

The spindle runs in solid bronze boxes of the standard type used on Garvin milling machines. It has a No. 11 B. & S. taper hole and a driving slot for the arbor. The spindle is driven by a gear 20 inches in diameter. The spindle block has a micrometer vertical adjustment and it is clamped in "V" grooves by four bolts which bind the headstock and spindle block rigidly together. A large arm carries an intermediate yoke for the arbor, and the outer end of the arm,

as well as the outboard bearing of the arbor, is supported by a framed base bolted to the bed. The driving pulley shaft is fitted with ring oilers. An oil reservoir is formed in the base, and the oil, after being used, passes through an overflow nozzle and an intermediate strainer trough, into the reservoir. A pump and piping are included in the equipment.

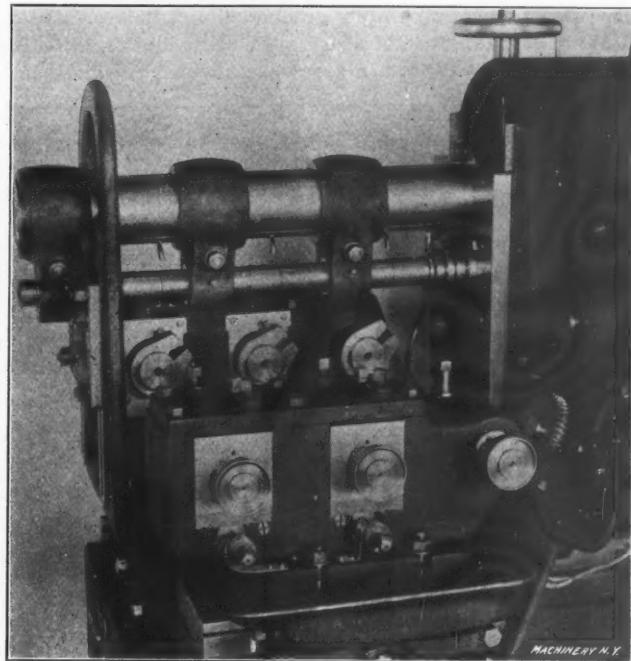


Fig. 2. Index Milling Machine equipped with 3-spindle Centers

The general dimensions of this machine are as follows: Working surface of the table, 12 by 42 inches; length of feed, 14 inches; greatest distance from center of spindle to top of table,  $15\frac{1}{2}$  inches; minimum distance from center of spindle to top of table,  $6\frac{1}{2}$  inches; distance between the head and braces, 24 inches; swing under the arm for cutters,  $5\frac{1}{2}$  inches; dimensions of front spindle bearing, 3 by  $4\frac{1}{2}$  inches; floor space, 64 by 54 inches; domestic shipping weight, 4550 pounds; export shipping weight, 5200 pounds.

#### DRAFTSMAN'S SEGREGATED SCALE

Every draftsman has experienced the difficulty of setting dividers to dimensions containing small fractional parts of an inch, as the required division on a finely-divided scale cannot be located so quickly or easily as the principal or larger fractions.

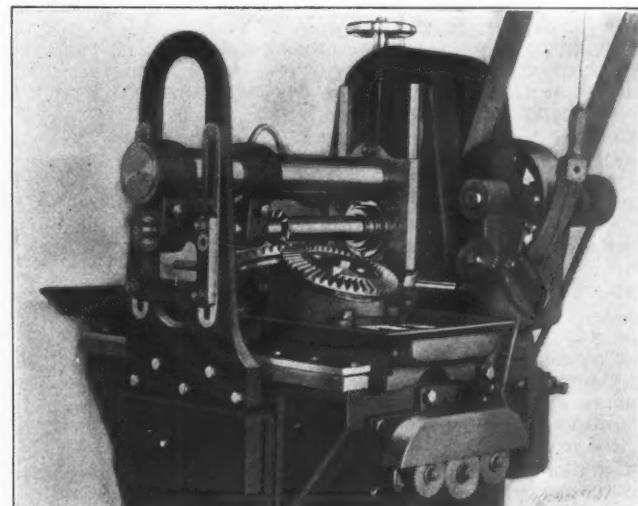


Fig. 3. Special Tandem Fixture for Cutting Bevel Gears in Automatic Index Milling Machine

tions. For example, it is much easier to set a pair of dividers to  $\frac{1}{2}$  or  $\frac{3}{4}$  inch, than to some fraction containing a smaller subdivision of the scale, such as sixty-fourths or hundredths. The draftsman's scale illustrated herewith, which is known as the "segregated" scale, is so designed that any subdivision within its capacity can be quickly located. As the illustration

shows, this scale is simply a table or chart having a horizontal base-line and a series of short dashes, beginning at zero and advancing by the unit of division, up to the capacity of the scale which, in the present instance, is 2 inches. As each dimension is separated from the others, it follows that it is just as easy to set an instrument to  $53/64$  as it is to  $1/2$  or  $3/8$  inch. This scale is accurately graduated, and it is printed on the finest grade of Bristol board. The base-line is scored or depressed slightly to form a groove into which the stationary

a lever which also controls the operation of the clutch for the driving mechanism of the chuck. A handwheel feed graduated to 0.00025 inch is also provided. This machine can be equipped with chucks ranging from 6 to 20 inches in diameter, and with cup-wheels varying from 8 to 12 inches in diameter.

**Vise:** The Emmert Mfg. Co., Waynesboro, Pa. Rapid-acting vise especially adapted for the work of the patternmaker, and for woodworkers in general. In its design, particular attention was given to the locking device, the aim being to secure simplicity, positiveness, and durability. The vise is locked and unlocked automatically by simply turning the vise handle

or lever about one quarter of a revolution to the right for locking, and the same distance to the left for unlocking. A noteworthy feature in connection with this locking device is that the nut encircles the lock-rod, so that when pressure is applied, the rod is gripped firmly on two sides. This type of vise is built in a number of different sizes, having a maximum capacity between the jaws ranging from 6 to 20 inches.

**Automatic Indexing Multiple Drill:** Langelier Mfg. Co., Providence, R. I. Multiple drilling machine adapted to the drilling of Jacquard loom "cylinders." As the holes have to be spaced very close, spindles are only provided for each alternate hole, in order to make possible a rigid and powerful spindle construction. After a row of holes representing half the number required in a row, has been drilled, the head automatically shifts sideways, bringing the drills into a position midway of the holes previously drilled. With the American or French index, the machine bores 240 holes per minute,

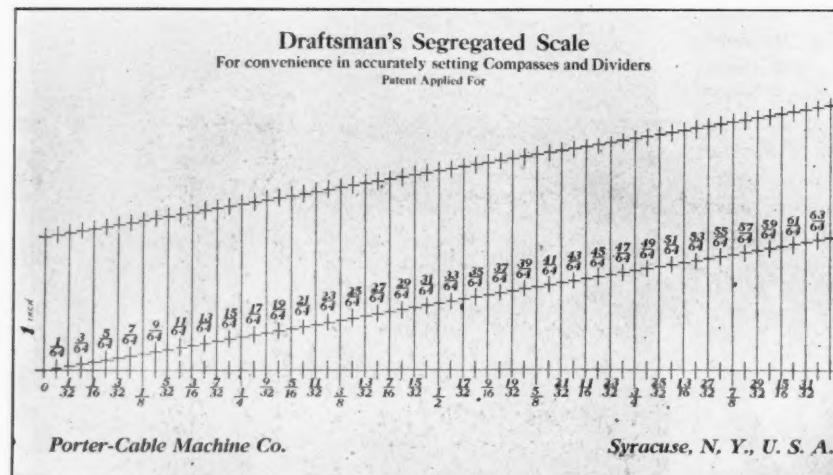
and with a "fine" index, 320 holes per minute. After the last row of holes is drilled, the machine stops automatically. By pressing a foot lever, the table is returned to its starting position.

**Milling and Drilling Machine:** W. B. Knight Machinery Co., 2019 Lucas Ave., St. Louis, Mo. Combined milling and drilling machine particularly adapted to the making of dies, jigs, molds, metal patterns, etc. The general construction of this machine, which is the No. 1½ size, is similar to the No. 1 size illustrated in the department of New Machinery and Tools for October, 1910, though it is somewhat larger and much more heavily constructed. Some of the principal dimensions of this new size are as follows: Vertical movement of the spindle, 4 inches; vertical adjustment of the spindle head, 10 inches; distance from center of spindle to column, 8½ inches; working surface of table, 7½ by 24 inches; cross movement of table, 16½ inches; transverse movement, 8 inches; maximum distance from table to spindle, 15½ inches; drill chuck capacity, 1-16 to 3-4 inch; diameter of circular attachment, 12 inches; maximum opening of vise jaws, 3½ inches; and net weight, 1125 pounds.

**Horizontal Boring Machine:** Lucas Machine Tool Co., Cleveland, Ohio. Improved horizontal boring machine that is also adapted to vertical and horizontal milling operations. This machine is driven by a single constant-speed pulley, through a geared speed-box giving nine changes, which number is doubled by back-gears located in the head. The speed-box is entirely closed, there being sliding plates under the controlling levers to prevent the entrance of dust or other foreign matter. The spindle is of forged steel and it has a large tapered front bearing, similar to modern milling machine construction. Eighteen feed changes are available, ranging from 0.004 to 0.600 inch per revolution of the spindle, and the feeding movement is so derived that it is dependent upon the spindle speed. By means of an ingenious design of distributing box, feeds can be imparted to the head, spindle, table or platen, as desired. A power traverse is provided which operates for the particular feeding movement selected, and its direction is always opposite to that of the feed, thus eliminating any chance of spoiled work by engaging the power traverse by mistake. A locking device prevents the engagement of more than one feed at a time. The boring-bar of this machine is 3½ inches in diameter and it has a total traverse of 48 inches. This machine is adapted to a wide range of surface milling by the insertion between the column and outboard support, of a cross-rail carrying a heavy vertical milling spindle. This spindle is driven through bevel gears by the regular boring-bar, and the milling head can be fed along the rail either by hand or by the power traverse of the boring-bar. All vertical adjustments can also be effected either by hand or power as desired.

\* \* \*

Cast iron or malleable iron that has been sand-blasted instead of pickled for cleaning the surface, gives, according to the *Brass World*, much better results in electroplating, as there is less liability to "spot out." Many platers have, therefore, abandoned the pickling of castings.



Draftsman's Scale designed to facilitate setting Dividers to Fractional Dimensions

leg of the dividers will readily fall. As will be appreciated, the sharp points of a fine instrument will not be injured by the use of this scale, and it may be replaced when worn out or soiled at a slight expense. These scales are graduated in sixty-fourths, as shown in the illustration, or in hundredths; they are made by the Porter-Cable Machine Co., 501 East Water St., Syracuse, N. Y.

#### NEW MACHINERY AND TOOLS NOTES

**Grindstone Truing Device:** Athol Machine Co., Athol, Mass. Adjustable grindstone truing device with provision for clamping to flanged grindstone frame not over 14½ inches wide. The results obtained with this device are said to be highly satisfactory.

**Shop Truck:** Lansden Co., Newark, N. J. Electrically-driven power truck for shop use, built in three different styles and equipped with the Edison storage battery. The driving wheels are provided with the usual type of solid rubber tire, and the design of the carrying platform is governed in each case by individual requirements.

**Friction Clutch:** A. S. Baldwin & Co., Sharon, Pa. Friction clutch applicable to the driving of machine tools, automobiles, motor boats, etc. In the operation of the clutch, a sectional tapering ring is expanded radially by wedge-shaped pieces on a sliding clutch-spool, which forces the gripping members against the friction disks. The design of this clutch is simple and compact.

**Friction Clutch:** J. G. Blount Co., Everett, Mass. Friction clutch intended for use on lineshafts, etc. The friction surfaces on the expanding member are large, to insure durability. When the clutch is used for driving speed lathes, an automatic brake is provided which is released by the movement of the shifter-rod when the clutch is engaged, and is thrown into action when the clutch is disengaged.

**Pipe Threading Tool:** Toledo Pipe Threading Machine Co., Toledo, Ohio. Pipe threading tool adapted to pipes ranging from 2½ to 6 inches in diameter, with one set of dies. The dies are shifted easily and positively by hand. When changing their position, a spring-bolt engages a rack that, in turn, engages a taper pin which causes the dies to recede. Two sets of dies are furnished, so that when one set becomes dull, the other can be substituted.

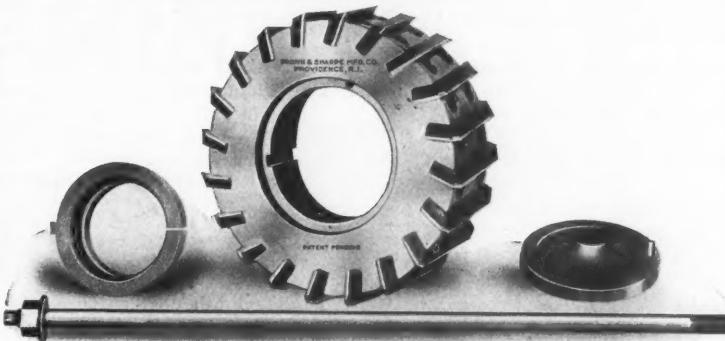
**Ball Bearing:** B. L. Co., Norwich, Conn. Ball bearing of chrome nickel steel having imported balls made within a limit of 0.0001 inch. The design is such that the entire space occupied between the balls by the retainer, is equal to the space required for one ball, thus allowing a large number of balls in the bearing. The retainer has a certain amount of elasticity which allows the balls to crowd or extend at certain points, as they naturally tend to do, but they are not permitted to touch one another.

**Surface Grinder:** Bay State Grinder Co., Worcester, Mass. Rotary surface grinder of the vertical-spindle cup-wheel type. The work is held on a magnetic chuck, mounted on a knee that is fed vertically to an adjustable stop. This feed is by

## Heavy duty—service which milling machines and cutters must often perform.

After work has been laid out, the first thing to be taken into consideration is the choice of a machine and cutter.

If it is a face milling job, for example, a vertical spindle milling machine and inserted tooth cutter are usually selected. To the following we call attention.



## No. 3 Vertical Spindle Milling Machine AND B. & S. Inserted Tooth Face Milling Cutters

The capacity of a milling machine is limited by several factors outside of the size and extent of travel of the table. Heavy and fast cuts cannot be successfully taken unless the work is rigidly held in place.

### Power and Rigidity are Essential

Note the style of the pulley which takes a wide belt running at high speed and insuring large belt contact—elements of power.

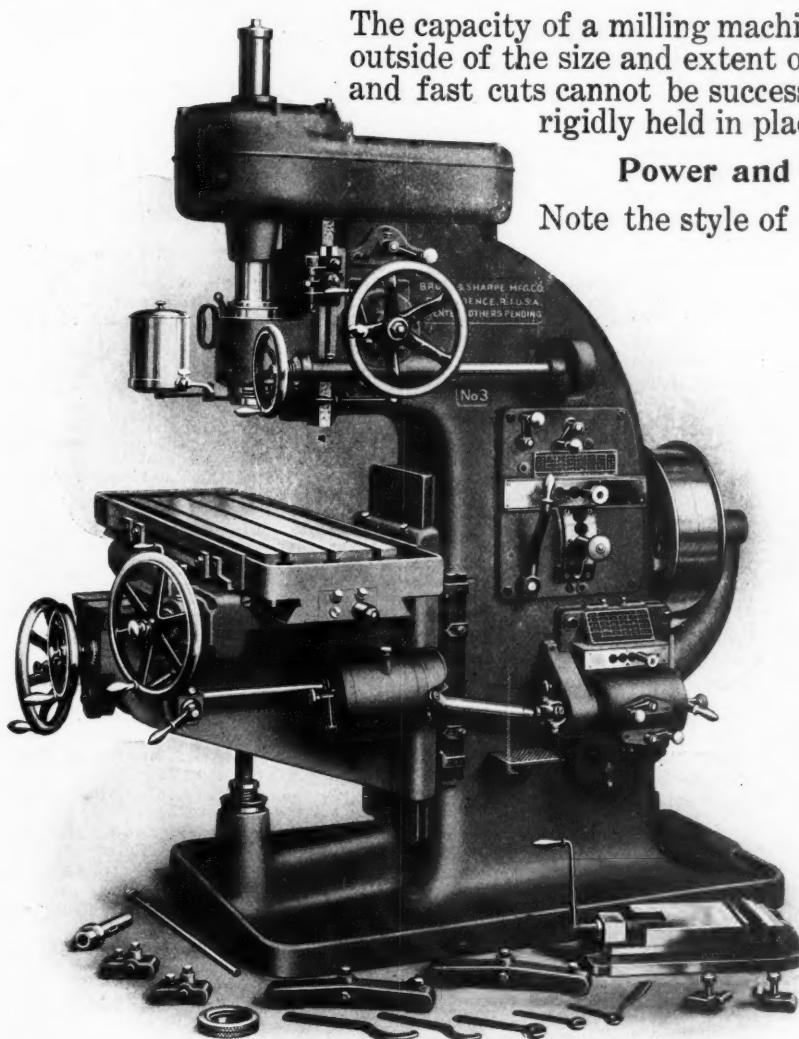
Study the massiveness of the frame, the length of the saddle, the depth of the table and the rugged knee—essential to rigidity.

### And the Cutter

The one shown in the cut is new in design. Its features are:

**Quick Release:** It is never jammed on to the nose of the spindle, no matter how heavy the cut, and

**Interchangeability:** One cutter can be used on several machines of different size spindles—economy.



*Send for circulars of both.*

**BROWN & SHARPE MFG. CO.**  
PROVIDENCE, R. I., U. S. A.

## PERSONALS

A. C. Hunter has left Pittsfield, Mass., and is now foreman in the Auto Truck Works at Detroit, Mich.

George E. Frost, for several years foreman of the tape department of the L. S. Starrett Co., Athol, Mass., has resigned.

George E. Hodson, first vice-president of the Winchester Repeating Arms Co., New Haven, Conn., has been elected president of the company.

Frank C. Harmon, foreman of the saw department of the Goodell-Pratt Co., Greenfield, Mass., has left this company to take up out-of-door work.

L. T. Wilmarth, president of the Wilmarth & Morman Co., 580 Canal St., Grand Rapids, Mich., has left for Los Angeles, Cal., for a six weeks' vacation.

David M. Hood, for sixteen years general foreman of the Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass., has severed his connection with that company.

M. H. Westbrook, formerly foreman of the Grand Trunk Railway shops at Battle Creek, Mich., has resigned his position and is now connected with Joseph T. Ryerson & Son, Chicago, Ill.

George J. Thompson has resigned from the Garvin Machine Co., Spring and Varick Sts., New York, and is now connected with the sales department of Manning, Maxwell & Moore, Inc., 85-89 Liberty St., New York.

Louis M. Zach has resigned as mechanical expert with the Wells Bros. Co., Greenfield, Mass., and will, after March 1, be connected with the firm of Wickes Bros., Saginaw, Mich., in a designing and estimating capacity.

H. H. Pinney, who for several years has been manager of the Union Metallic Cartridge Co., of Bridgeport, Conn., has resigned and will in the future be manager of the works of the Chalmers Motor Co., Detroit, Mich.

A. L. Lovejoy has resigned his position as sales manager of the New York office of the Pratt & Whitney Co., and will after March 1 be manager of the Chelsea division of the Flanders Mfg. Co., with headquarters at Chelsea, Mich.

Thomas G. Bennett, for many years president of the Winchester Repeating Arms Co., New Haven, Conn., has resigned on account of poor health. He will still be active in the affairs of the company in the newly-created office of consulting director.

Herbert T. Fisher, for the past five years manager and treasurer of the Granite State Mowing Machine Co., Hinsdale, N. H., has severed his connection with this company, and is now general office and sales manager for the Wells Bros. Co., Greenfield, Mass.

Frank Koester, previously employed with the Interborough Rapid Transit Construction Co., J. G. White & Co., the Guggenheim Exploration Co., and the American Smelting and Refining Co., all of New York, has recently opened an office at 115 Broadway, New York, as consulting engineer.

E. T. Hendee, assistant to the president of the firm of Joseph T. Ryerson & Son, Chicago, Ill., and C. A. Johnson, president of the Gisholt Machine Co., Madison, Wis., sailed for Europe February 1 on a six weeks' trip in the interests of the foreign business of their respective firms.

Ralph E. Flanders, formerly associate editor of MACHINERY, and now with the Fellows Gear Shaper Co., 25 Pearl St., Springfield, Vt., delivered a lecture on "The Design and Manufacture of Spur Gearing" Friday, February 17, before 250 mechanics at the Central Y. M. C. A. of Cleveland, Ohio.

James Greenaway, for several years foreman of the machine shop of the Chapman Valve Mfg. Co., Springfield, Mass., and for the past two years foreman of the machine department of the Stevens-Duryea Co., Chicopee Falls, Mass., has returned to the Chapman Valve Mfg. Co. as general foreman of the machine shops.

Lewis H. Morgan, who was formerly superintendent and general manager of the Ridgway Machine Co., Ridgway, Pa., and also for many years with the Pond Tool Works, Plainfield, N. J., and who is now settled in England, has been elected a member of the Institute of Mechanical Engineers, London.

Edward Blake, Jr., who has been sales manager for the Wells Brothers Co., Greenfield, Mass., for the past four years, and also a director of the company, has severed his connection with this concern and is now connected with the Canadian Tap & Die Co., Ltd., Galt, Ontario, Canada, in which he has obtained a controlling interest.

Dyer Smith, who was an associate editor of MACHINERY in 1904 and 1905, has resigned from the legal department of Thomas A. Edison and the affiliated Edison companies, and has opened an office at No. 2 Rector St., New York, where he will continue his practice in connection with patents and patent causes, trademarks and copyrights. Mr. Smith graduated from Lehigh University with the degree of Mechanical Engineer in 1903. After some practical experience in the machine shops and around the open hearth furnaces and blast

furnaces of the Bethlehem Steel Co.'s plant, at Bethlehem, Pa., he became an assistant to Dr. Edward J. Houston in the preparation of several books on technical and industrial subjects, after which he became an associate editor of MACHINERY. Thereafter he was an assistant examiner in the United States Patent Office in Washington, having charge particularly at different times of the examination of patent applications for inventions in cash registers, coin handling appliances, workman's time recorders and automatic telephone systems. In the spring of 1908 he joined the legal staff of Thomas A. Edison and the associated Edison companies, in which position he prepared and prosecuted practically all of Mr. Edison's personal patent applications and the patent and trade mark applications of the affiliated Edison companies, chiefly in the arts of phonographs and sound records, storage batteries, moving picture apparatus, and the Portland cement industry. He also was associated as counsel in various litigations concerning the patents owned and controlled by the Edison companies.

\* \* \*

## OBITUARIES

Simon Wing, inventor of the first multiplying camera and many other photographic devices, died at his home in Charlestown, Mass., aged eighty-four years.

Frederick G. Hesse, aged eighty-six years, died at his home in Oakland, Cal., January 27. Prof. Hesse was connected with the department of mathematics and mechanical engineering at the University of California for twenty-nine years.

Edward L. Bowers, superintendent of the New Home Sewing Machine Co., Orange, Mass., died at his home, February 2, aged fifty-four years. Mr. Bowers began to work for the New Home Sewing Machine Co. thirty years ago as draftsman, from which position he was rapidly promoted. He was born in East Berlin, Conn., and "served his time" with the Pratt & Whitney Co., Hartford, Conn.

\* \* \*

## COMING EVENTS

March 4-11. Ninth annual show of the Licensed Automobile Dealers Association, Mechanics Bldg., Boston, Mass.

March 9.—Monthly meeting of the Institute of Operating Engineers at the Engineering Societies Bldg., 29 W. 39th St., New York. Prof. Wm. D. Ennis of the Polytechnic Institute of Brooklyn will read a paper entitled "Commercial Aspects of the Work of the Operating Engineer."

April 3-5. Annual convention of the Southern Supply and Machinery Dealers' Association; National Supply and Machinery Dealers' Association; and American Supply and Machinery Manufacturers' Association, Louisville, Ky. T. D. Mitchell, 309 Broadway, New York, secretary and treasurer, American Supply and Machinery Manufacturers' Association.

April 10-11. Congress of Technology, Boston, Mass. Walter B. Snow, publicity manager, 170 Summer St., Boston, Mass.

April 12-13. Thirteenth annual convention of the National Metal Trades' Association at Hotel Astor, New York.

May 30-JUNE 2.—Sixty-third meeting of the American Society of Mechanical Engineers, at Pittsburg, Pa. Office of local committee, 2511 Oliver Bldg., Pittsburg, Pa.

June 14-16.—Annual Convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Building, Chicago.

June 14-21.—Annual convention of the Railway Supply Manufacturers Association, in conjunction with the American Railway Master Mechanics' and Master Car Builders' Association, Atlantic City, N. J. J. D. Conway, secretary, 2135 Oliver Bldg., Pittsburg, Pa.

June 19-21.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

## CATALOGUES AND CIRCULARS

DESMOND-STEPHAN MFG. CO., Urbana, Ohio. Leaflet listing emery wheel dressers.

RACINE TOOL MACHINE CO., Racine, Wis. Leaflet of Racine high speed saws.

ROCKFORD LATHE & DRILL CO., Rockford, Ill. Folder of loose-leaf sheets, describing this firm's lathes and drills.

LINK-BELT CO., Philadelphia, Pa. Leaflet illustrating the Ewart friction clutch and the Link-Belt disk friction clutch.

HESS-BRIGHT MFG. CO., Philadelphia, Pa. Leaflets describing magneto bearings and centrifugal basket mountings.

CUTLER-HAMMER MFG. CO., Milwaukee, Wis. Catalogue listing and describing the Schureman types of elevator controllers.

FORT WAYNE ELECTRIC WORKS, Fort Wayne, Ind. Souvenir book of Fort Wayne, containing over two hundred illustrations of the city.

ROCKWELL FURNACE CO., 26 Cortlandt St., New York. Bulletin R, describing the Rockwell combination tool-room gas furnace, illustrating its various uses.

DE LAVAL STEAM TURBINE CO., Trenton, N. J. Booklet illustrating and describing the company's steam turbines for both high- and low-pressure.

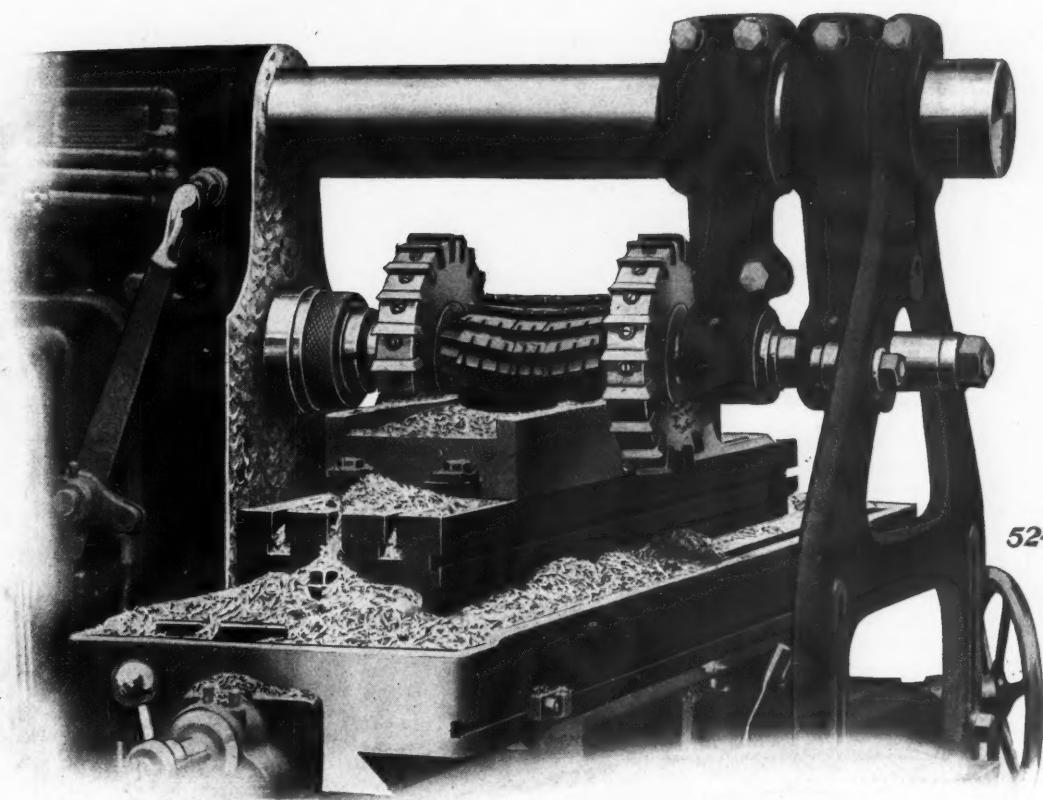
DIAMOND CHAIN & MFG. CO., 240 W. Georgia St., Indianapolis, Ind. Leaflet entitled "Chain Drive, the Logical Method for Commercial Vehicles."

T. R. ALMOND MFG. CO., Ashburnham, Mass. Catalogue of the Almond tool-holder, showing its construction in detail and setting forth its advantages.

RICHARDSON-PHENIX CO., Hudson Terminal Building, New York City. Bulletin No. 53, describing and illustrating the Richardson Model M mechanical lubricator.

SAFETY POWER TRANSMISSION CO., 114 Franklin St., New York City. Booklet illustrating and describing the "Safety Shaft Guard," manufactured by this company.

# NINETEEN CUBIC INCHES PER MINUTE



The total width of surface roughed off at one cut on these gray iron castings is  $16\frac{3}{8}$  inches—maximum depth of cut  $\frac{3}{16}$ "—length of cut on each piece  $8\frac{1}{4}$ "—largest cutters  $10\frac{1}{2}$ " diameter, running 21 rev.—6.3" feed.

The pieces are held in a string jig, removed as fast as traversed by the gang and others chucked in their places.

The pieces are made in lots of 125 at a time and an entire lot is regularly milled on a No. 4 Plain High Power Cincinnati Motor Driven Miller at this enormous rate without stopping to sharpen the cutters.

It takes a powerful, rugged machine to do such milling and it must go through without vibration—otherwise the cutters would be dulled, forcing a reduction in the feed, long before an entire lot of pieces is finished.

Our machines are designed for this kind of service.

*Get our complete Catalog.*

**The Cincinnati Milling Machine Company**  
CINCINNATI, OHIO, U. S. A.

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest and Prague. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow.  
CANADIAN AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne.  
JAPAN AGENTS—Andrews & George, Yokohama. CUBAN AGENT—Adolfo B. Horn, Havana.  
ARGENTINE AGENTS—Adolfo Mantels & Co., Buenos Ayres.

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GARVIN MACHINE Co., Spring and Varick Sts., New York City. Large-size chart, 25 by 25 inches, of decimal equivalents, suitable to hang on the wall in the shop or drafting room.

CLEVELAND PUNCH & SHEAR WORKS Co., Cleveland, Ohio. Catalogue of riveting tools, reamers, punches and dies, punch couplings, punch and shear machinery, bending rolls, etc.

BARBER-COLMAN Co., Rockford, Ill. Catalogue of carbon and high-speed steel milling cutters, attractively arranged, containing twenty-four pages of useful information and data.

MOORE & WHITE Co., Philadelphia, Pa. Catalogue for 1911, containing complete descriptions of the Moore & White lines of friction clutches and speed changing devices, all types being listed.

INGERSOLL-RAND Co., 11 Broadway, New York. Pamphlet No. 9003 entitled "Rock Drill Mountings, Steels, Hose and Accessories," completely describing these products and their uses.

C. H. HUGHES & Co., 82 Beaver St., New York. Leaflet calling attention to the "reports on the commercial possibilities of mechanical and electrical devices" of which this firm makes a specialty.

NORTHERN ENGINEERING WORKS, Detroit, Mich. Crane catalogue No. 25 is a compilation of several Northern bulletins in condensed form. The catalogue illustrates the application of the cranes in practice.

WM. GAERTNER & Co., 5345-5349 Lake Ave., Chicago, Ill. Catalogue M-L, containing a very complete line of instruments of precision and practically all the apparatus needed for a physical laboratory.

E. R. CALDWELL & Co., 34-86 Hilton St., Bradford, Pa. Special circular No. 46, describing the Scranton upright power hammers, and containing a partial list of users and some testimonial extracts.

DELAVAL STEAM TURBINE Co., Trenton, N. J. Catalogue A devoted to the single stage type of turbine and containing so much information that it might be considered as a practical treatise on the subject.

SPRAGUE ELECTRIC Co., 527-531 W. 34th St., New York. Bulletin No. 111 containing a partial list of installations of this company's engine-type generators. Catalogue 436 describes the company's complete line of conduit products.

J. E. RHOADS & SONS, 12 N. Third St., Philadelphia, Pa. The latest catalogue production of this firm is in the form of a condensed book containing a large amount of useful belting information, with a number of rules and tables.

BRISTOL Co., Waterbury, Conn. Bulletin No. 127 on Bristol's Class III recording thermometers. This catalogue includes the compensated gas-filled thermometers for recording temperatures up to 800 degrees F., illustrated in the January, 1911, issue of MACHINERY.

E. F. LAKE, Consulting Metallurgist, 19 W. 43rd St., Bayonne, N. J. Pamphlet briefly outlining the different lines of heat treatment of iron and steel on which Mr. Lake is prepared to give expert advice, with the ultimate aim of improving the efficiency of plants.

PEERLESS V-BELT Co., 547 West Jackson Blvd., Chicago, Ill. Leaflet illustrating and describing the Peerless V-Belt silent chain drives, especially adapted for short center-power transmission from an electric motor to a driving pulley on the line-shaft or the machine.

GARDNER MACHINE Co., Beloit, Wis. Booklet on abrasive disks and how to use them. A unique feature of this little book is the small circular portion of an actual abrasive disk which is mounted on the first leaf of the booklet, and shows through a hole cut in the cover.

GENERAL ELECTRIC Co., Schenectady, N. Y. Bulletins: No. 4787, Wires and Cables, containing considerable data; No. 4811, Drum Controllers for Industrial Service; No. 4812, Small Direct-Current Generators of the Belted Type; and No. 4813, Oil Brake Switches for Pole Line Service.

NELSON VALVE Co., Philadelphia, Pa. Wall chart of valves, accompanied by one of the Nelson danger signals which have been designed to be hung up at dangerous points around a steam plant, etc. The danger signal is a round red card with a skull on it, below which is the legend "Danger, hands off."

TECHNICAL DATA & APPLIANCE Co., 92 LaSalle St., Chicago, Ill. has recently brought out a new publication called *Data* which is decidedly unique. It is a small book 3 by 5 inches, of the standard filing card size, the pages being printed on one side only. Nothing but compact data are given, and the sheets are merely glued together along the edges, so that they may be taken out and filed. Suggestions as regards filing are given.

GOULD & EBERHARDT, Newark, N. J. *Practical Hints* is the title of a little book issued by this firm, containing numerous suggestions arranged for ready reference in connection with the correct operation of their automatic gear-cutting machines and cutter grinders. It is really a small text-book on gear-cutting. The 1911 catalogue on shapers is also an attractively arranged booklet describing the latest production in this line, and illustrating many of the machines in operation.

## TRADE NOTES

WESTCOTT CHUCK Co., Oneida, N. Y. has recently been notified that it has been awarded the gold medal for the Westcott chucks, at the Brussels Exposition, 1910.

MEDHUS-PIHL MFG. Co., whose pliers were mentioned in the January number of MACHINERY, is located at Hastings, Minn., instead of Hastings, Mich., as was stated.

W. B. KNIGHT MACHINERY Co., St. Louis, Mo., will have an exhibit at the Boston Automobile Show, held in the Mechanics Bldg., March 4-11. Mr. Knight will be in charge of the exhibit.

LANDAU & HOWE, 1779 Broadway, New York, have opened a branch of their consulting and designing engineer's office at 701 Fireman's Insurance Bldg., Newark, N. J., in charge of Richard A. Shaaf.

PAWLING & HARNISCHFEGER Co., Milwaukee, Wis., builder of cranes, hoists, etc., announces the opening of a branch office at 533 Baronne St., New Orleans, La., under the management of T. W. Waddell.

E. R. KLEMM, manufacturer of cutting-off saws, stone jacks, grinding machinery, etc., is erecting a new shop at 1447 Austin Ave., Chicago, Ill. The new plant is 90 x 145 feet, two stories, and will be ready for occupancy about May 1.

SCRANTON & Co., New Haven, Conn., announce that the manufacture and sale of the Scranton improved upright power hammers which they formerly conducted will in the future be in charge of E. R. Caldwell & Co., Bradford, Pa.

QUEEN CITY PUNCH & SHEAR Co., Cincinnati, Ohio, announces the removal of its plant to the corner of Front and Pike Sts., into the building formerly occupied by the Bickford Tool Co. The capacity of the plant will be doubled, enabling orders to be handled more expeditiously.

JOSEPH T. RYERSON & SON, Chicago, Ill., at the annual meeting of the directors January 23, elected the following officers: Clyde M. Carr, president; Jos. T. Ryerson, vice-president and treasurer; Gilbert H. Pearsall, secretary; and Edward L. Ryerson, chairman of the board of directors.

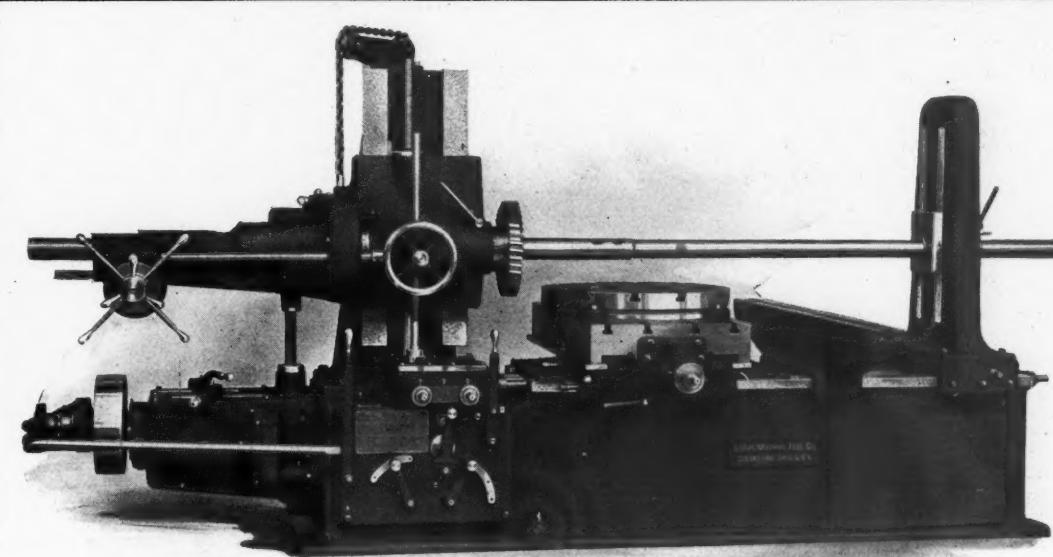
BRUNSWICK GAS ENGINE Co., New Brunswick, N. J., announces its advent into the field of automobile gas-engine manufacture. The purpose of the company is to manufacture engines designed to fill the particular needs of the customer, instead of marketing a standard engine. A staff of designing and production engineers will be maintained. Inquiries are solicited.

CANADIAN RAILWAY CLUB held its ninth annual dinner at the Windsor Hotel, Montreal, January 27, 1911. Among the guests present were many prominent machine tool builders from both sides of the line as well as representative railway men. The reply to the toast to the railway supply men was made by G. H. Pearsall, secretary of Joseph T. Ryerson & Son, New York and Chicago.

BAKER BROS., Toledo, Ohio, has nearly completed a fine power plant, equipped with a 175 h. p. Northern generator and Hamilton-Corliss engine. Two McNaull water-tube boilers are provided as steam generators, and space is available for a third boiler. The engine and boiler house are of absolute fireproof construction, being built with concrete roofs, thick walls and a "tarrazzo" floor in the engine room.

CAMMELL, LAIRD & Co., Ltd., Sheffield, England, has recently formed an American company to handle its business in this country. This new corporation is known as "Cammell Laird & Co. of New York," and its main office and warehouse will be located at No. 34 Cliff St., New York. A large stock of English tool and high-speed steel will be carried. The officers of the company are: Leonard Munn, president; Lionel Samuel, secretary and manager; and Alexander Muir, treasurer.

RACINE TOOL & MACHINE Co., Racine Junction, Wis., maker of the Racine high-speed metal-cutting saw, has moved into its new factory. The building is 40 by 100 feet, two stories and basement. The walls are cream-colored pressed brick, and the floors are supported by heavy steel beams and cast-iron columns, the floor rating being 400 pounds per square foot. The largely increased capacity of the



**THE LUCAS (OF CLEVELAND)**

**“PRECISION”**

**Boring, Drilling and Milling Machine**

**IS AS GOOD AS WE SAY IT IS**

**(and some of our customers say it is better)**

**We KNOW it is BETTER THAN EVER**

**HERE IS THE LATEST**

*Send for circular.*

**LUCAS MACHINE TOOL CO.**

**CLEVELAND, OHIO, U. S. A.**

**AGENTS—**C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Stockholm, St. Petersburg, Copenhagen. Donauwerk Ernst Krause & Co., Vienna and Budapest. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal.

new plant will enable the company to take better care of its rapidly increasing business.

E. P. REICHELM & Co., Inc., 24 John St., New York, announce that the business established in 1876 by the senior partner, Mr. E. P. Reichhelm, has been incorporated under the above name for the purpose of perpetuating the name and protecting the interests of all concerned from the consequences of the withdrawal or death of either partner. The new corporation assumes all liabilities, the original members of the firm becoming stockholders and directors. The new company has a capital of \$300,000 common stock.

FENWICK FRERES & Co., Paris, France, who represent a large number of American machine builders in France, Belgium, Switzerland, Italy, Spain and Portugal, have just been made into a stock company, the principal stockholders being Francis Fenwick, president; Charles Fenwick, vice-president, and F. Mandon, general manager. The new company is a continuation of the present firm, the only change being a slight difference in the name to conform to the French laws. Messrs. Fenwick Freres were one of the first concerns to represent American machine tool builders on the Continent, and have consistently followed the policy of selling only American-made tools, instead of placing foreign-made tools in competition with those of the manufacturers they represent; and in this and other particulars they have earned a high and well-deserved reputation with our manufacturers.

### MISCELLANEOUS

Advertisements in this column, 25 cents a line, ten words to a line. The money should be sent with the order. Answers addressed to our care will be forwarded. Original letters of recommendation should not be enclosed to unknown correspondents.

AGENTS IN EVERY SHOP WANTED to sell my sliding Calipers. Liberal commission. ERNST G. SMITH, Columbia, Pa.

AGENTS wanted in every works in Great Britain where draftsmen, machinists and tool-makers are employed, to represent MACHINERY and take orders for MACHINERY's remarkably successful Reference Books. Special offers in force in Great Britain for a limited time only, give a choice of 65 Reference Books and 20 new Data Books sold at a shilling per copy, and a subscription for MACHINERY, cash or credit. No charge is made for credit. We supply sample copies and advertising matter describing the books in detail for distribution in Engineering Works. Write us for full information. WM. DAWSON & SONS, LTD., Cannon House, Bream's Bldgs., London, E. C.

CHIEF INSPECTOR WANTED by Automobile Factory in Middle West, employing 2,000 hands. Must be familiar with and capable of handling large and high-class product. When replying, state experience, salary expected and references. Address Chief Inspector, care MACHINERY, 49 Lafayette St., New York.

DRAFTSMEN AND MACHINISTS.—American and foreign patents secured promptly; reliable researches made on patentability or validity; twenty years' practice; registered; responsible references. EDWIN GUTHRIE, Corcoran Building, Washington, D. C.

DRAFTSMAN WANTS POSITION.—At present in charge small office and designing machinery. Prefers similar position with small, growing concern where there would be a chance to work into Sales Department. Address box 354, care MACHINERY, 49 Lafayette St., New York.

ENGINEERING, DESIGNING, PHYSICAL AND CHEMICAL TESTS OF MATERIALS.—We are Specialists in automobile design, internal combustion motors for all purposes and power applications. We test and report on motors, mechanism and manufacturing projects, design and detail from your ideas, and, if desired, build and test the first machine. Strict privacy for such work. Do you want a specialty to manufacture? Landau & Howe, Engineers, 1781 Broadway, New York.

EXPERT DESIGNING—IDEAS DEVELOPED by a practical manufacturer. Tool equipment for the manufacture of metal goods a specialty, also power plant arrangement. Best results assured. Lowest prices. Address Lock Box 41, Indianapolis, Ind.

FACTORY FACILITIES WANTED.—Small electrical or mechanical articles to manufacture for selling agents. First-class factory and equipment already engaged in similar work. Practical superintendent in charge. Address with and for particulars, Factory, box 167, Boston.

FOREIGN REPRESENTATIVE.—Energetic young man, with mechanical knowledge, and able to correspond in English, wishes the agency, for Belgium, of machines of all kinds, and also of all articles used in machine shops. Pochet, 49 rue du Parc, Liege, Belgium.

FOMULAS AND TABLES FOR SHOP AND DRAFTING ROOM is No. 35 in MACHINERY'S Reference Series, and for practical use in mechanical work is undoubtedly the most widely technical useful book published in years. Send for free pamphlet with new offers. Address MACHINERY, 49 Lafayette St., New York.

FOR SALE.—32-H.P. and 14-H.P. Backus Gas Engines, Line shaft and other equipment, Bliss No. 30 $\frac{1}{2}$  combination back-gearred and direct-drive punch press. All of the above machines in the best of condition, can be seen at any time. Ellis Adding Typewriter Co., 204 Morris Ave., Newark, N. J.

FOR SALE AT VERY REASONABLE PRICES.—1 Needle Swaging Machine, 1 Heartly-Toledo Rolling Machine, 1 Draw Bench; all almost new. For particulars and prices address box 350, care MACHINERY, 49 Lafayette St., New York.

FOR SALE OR LEASE.—Machine shop 35' x 100', substantial brick building and lot 66' x 280', conveniently located in a good manufacturing town out of Chicago having accessible shipping facilities by boat and rail, including a Chicago outer belt line. Machine shop is adequately equipped with working capacity of 25 men or over, a pattern shop for 3 pattern makers, storage rooms, boiler house and boiler and shipping room. An office building 24' x 24' and casting shed 24' x 24' are included in premises. We are in position to make an excellent proposition to parties interested. Address box 351, care MACHINERY, 49 Lafayette St., New York.

GRINDERS WANTED.—First-class men on Norton Crankshaft Grinders; also on Internal and Plain Grinders. Steady employment for good men. F. I. A. T., Poughkeepsie, N. Y.

INTERCHANGEABLE MANUFACTURING WANTED.—We have an A-1 organization, experienced in manufacture of firearms, typewriters, adding machines, etc. We also have complete modern machinery and equipment for two to three hundred employees and would be glad to take on additional manufacturing in connection with our regular product. Address box 343, care MACHINERY, 49 Lafayette St., New York.

MASTER MECHANIC AND ASSISTANT SUPERINTENDENT for a large machine shop, with long and valuable varied experience, is open for engagement. Experienced in estimating, maintenance of plant, motive power and tool departments. Thoroughly familiar with modern apprentice systems and very successful in handling men. Record the very best. Address Mechanic, care MACHINERY, 49 Lafayette St., New York.

MILLING MACHINE HANDS WANTED.—First-class men for Cincinnati Plain and Universal machines. Steady employment, good wages. Address F. I. A. T., Poughkeepsie, N. Y.

PATENTS.—H. W. T. Jenner, patent attorney and mechanical expert, 608 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. Trade-marks registered.

POSITION WANTED—MECHANICAL STRUCTURAL ENGINEER.—By a young man, college graduate. Good draftsman and designer. Ambitious and capable. Willing to begin at the bottom. City preferred. Address A. B. Tappan, 1117 Westchester Ave., New York.

POSITION WANTED BY EXPERIENCED CHIEF DRAFTSMAN who has had charge in the designing of large pumping engines, mining engines, boilers, marine engines and marine turbines. First-class references. Address box 361, care MACHINERY, 49 Lafayette St., New York.

PROFITABLE HARDWARE PATENT FOR MACHINE SHOP.—If interested, write W. N. Mesick, 1 Bradford St., Albany, N. Y.

SALESMAN.—SEVEN YEARS' EXPERIENCE AUTOMOBILE INDUSTRY, Illinois, Indiana, Ohio, Michigan, would introduce machine tools adapted for rapid production of automobile parts; has wide acquaintance. Address box 352, care MACHINERY, 49 Lafayette St., New York.

SEVERAL DRAFTSMEN WANTED.—Applications solicited from men with either ordnance, mechanical-electrical or mechanical-structural experience. State fully age, experience, education and salary expected. Address box 347, care MACHINERY, 49 Lafayette St., New York.

SITUATION WANTED by man 32, competent to take charge of Shop System. Eight years' factory experience, including stock-keeping and time. Four years in charge of work scheduling. Can handle men and carry responsibility. Address box 357, care MACHINERY, 49 Lafayette St., New York.

SITUATION WANTED by Mechanical Engineer with years of experience in the designing and construction of special and automatic machinery, and all kinds of tools. Competent to officiate in any part of mechanical business, office, drawing-room or factory. Up-to-date in manufacturing of interchangeable parts; A-1 references. Address box 353, care MACHINERY, 49 Lafayette St., New York.

STEAM HAMMER EXPERT, who has had practical and successful experience and can handle the Engineering and Sales end of this or Steam-Hydraulic Presses, would make change if better than present connection. Address box 355, care MACHINERY, 49 Lafayette St., New York.

TEST INDICATORS.—H. A. Lowe, 1374 East 88th St., Cleveland, Ohio.

WANTED.—Agents, machinists, toolmakers, draftsmen, attention! New and revised edition Saunders' "Handy Book of Practical Mechanics" now ready. Machinists say "Can't get along without it." Best in the land. Shop kinks, secrets from note books, rules, formulas, most complete reference tables, tough problems figured by simple arithmetic. Valuable information condensed in pocket size. Price postpaid \$1.00, cloth; \$1.25, leather with flap. Agents make big profits. Send for list of books. E. H. SAUNDERS, 216 Purchase St., Boston, Mass.

WANTED.—A man having both technical and practical experience to take charge of a Night School for our employees. During the day the instructor will spend part of his time in Drafting Room or Tool Room work. Give full information in regard to qualifications; state salary expected, etc., sending reply to box 362, care MACHINERY, 49 Lafayette St., New York.

WANTED.—HIGH-CLASS GENERAL FOREMAN for machine shop making special automatic machines, employing three hundred and fifty men. Permanent position. Good salary. Only high-grade men need apply. Address box 358, care MACHINERY, 49 Lafayette St., New York.

WANTED.—FOREMAN for light structural iron and heavy automatic machinery assembling department. Must be excellent mechanic. Good salary. Permanent position. Address box 359, care MACHINERY, 49 Lafayette St., New York.

WANTED.—EXPERIENCED BRASS FOUNDRY FOREMAN for foundry employing 12 molders using latest equipment, making high-class castings only. Good salary. Permanent position. Address box 360, care MACHINERY, 49 Lafayette St., New York.

WANTED.—MACHINE SHOP FOREMAN who is up-to-date in modern Steam and Water Boilers and Radiator manufacturing. Must understand the business thoroughly and be wide awake. Good opportunity for young, energetic Scandinavian wishing to go to Sweden. Advise age, experience, present and past employment; give references. Only sober and competent man will be employed. Address H. 311, care of S. Gummel Announcebureau, Stockholm, Sweden, t.b.f.

WANTED.—FIRST-CLASS OPERATOR ON CLEVELAND AUTOMATIC. The Standard Machinery Co., Mystic, Conn.

WANTED.—A first-class Machine Tool Designer. Prefer one experienced on Grinding Machinery. Address box 356, care MACHINERY, 49 Lafayette St., New York.

WANTED.—FACTORY LOCATION. We are looking for a new factory location for our machine shop and foundry. We build heavy machinery and must have a side-track and buildings suitable for electric traveling cranes. Any factory sites or buildings that any city or Commercial Club has to offer will be considered. Bertsch & Co., Cambridge City, Ind.

WANTED.—MECHANICAL SUPERINTENDENT for large Engineering Works. Must have thorough knowledge of, and wide experience in, modern manufacturing methods. Apply Robert Wuest, Commissioner, National Metal Trades Association, 1405 New England Building, Cleveland, Ohio.

WANTED.—SECRETARY AND SALES MANAGER by twist drill manufacturer. Good opportunity for man with proper experience. Address box 349, care MACHINERY, 49 Lafayette St., New York.